BD4NRG
Big Data for Next Generation Energy

D6.1: Pilot Operation, Engagement and M&V Plan

WP6 – Pilot Requirements and Assessment

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Preface

BD4NRG focuses on addressing emerging challenges in big data management for energy sector with an innovative open holistic solution for smart grid-tailored, near real time, energy-specific and AI-based open Big Data Analytics modular framework. The vision is to deliver holistic services for techno-economic optimal management of Electric Power and Energy Systems value chain. Services range from optimal risk assessment for energy efficiency investments planning, to optimized management of grid and non-grid owned assets, improved efficiency, and reliability of electricity networks operation, while at the same time contributing to achieve fair energy prices to the consumers and laying the foundations for an EU-level energy-tailored data sharing economy. The BD4NRG Toolbox will be implemented and validated in real-life pilots in 12 large-scale demo sites across 10 countries for:

- Increasing the efficiency and reliability of the electricity network BD-4-NET

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- Optimising the management of assets connected to the grid BD-4-DER
- De-risking investments in energy efficiency and increasing the efficiency and comfort of buildings BD-4-ENEF

Who We Are

	Participant Name	Short Name	Country Code	Logo
1	ENGINEERING – INGEGNERIA INFORMATICA SPA	**ENG**	IT	
2	NATIONAL TECHNICAL UNIVERSITY OF ATHENS	**NTUA**	GR	
3	RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE AACHEN	**RWTH**	DE	
4	EUROPEAN DYNAMICS LUXEMBOURG SA	**ED**	LU	
5	INTERNATIONAL DATA SPACES EV	**IDSA**	DE	
6	EUROPEAN NETWORK OF TRANSMISSION SYSTEM OPERATORS FOR ELECTRICITY AISBL	**ENTSO-E**	BE	
7	PANEPISTIMIO DYTIKIS ATTIKIS	**UNIWA**	GR	
8	ATOS SPAIN SA	**ATOS**	ES	
9	FUNDACION CARTIF	**CARTIF**	ES	
10	UNIVERZA V LJUBLJANI	**UNILJ**	SL	
11	ENEL X SRL	**ENELX**	IT	
12	REN - REDE ELECTRICA NACIONAL SA	**REN**	PT	
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20	VIDES INVESTICIJU FONDS SIA	**LEIF**	LV	
21	COMSENSUS, KOMUNIKACIJE IN SENZORIKA, DOO	**COMSENSUS**	SL	
22	HOLISTIC IKE	**HOLISTIC**	GR	
23	INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM	**IMEC**	BE	
24	TERRASIGNA SRL	**TS**	RO	
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30	E-LEX - STUDIO LEGALE	**ELEX**	IT	
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Abbreviation & Acronyms

Acronym	Description
AHI	Asset Health Index
AI	Artificial Intelligence
APS	Advanced Pilot Stage
BESS	Battery Energy Storage System
BO	Business Objective
BPS	Basic Pilot Stage
BTM	Behind the Meter
CAIDI	Consumer Average Interruption Duration Index
CB	Circuit Breaker
DAS	Data Acquisition System
DER	Distributed Energy Resources
DR	Demand Response
DSO	Distribution System Operator
EC	European Commission
ECM	Energy Conservation Measure
EE	Energy Efficiency
EI	Expected Impact
EPC	Energy Performance Certificate
EPES	Electrical Power Energy System
ESCO	Energy Service Company
EU	European Union
EV	Electric Vehicle
EVSE	Electric Vehicle Service Equipment
FTM	Front of Meter

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Acronym	Description
GA	Grant Agreement
HV	High Voltage
HVAC	Heating, Ventilation, Air-Conditioning
ICT	Information Communication Technology
IPS	Intermediate Pilot Stage
ISP	Imbalance Settlement Period
IT	Information Technology
KPI	Key Performance Indicator
LSP	Large Scale Pilot
LV	Low Voltage
M&V	Measurement & Verification
MDP	Markov Decision Process
ML	Machine Learning
MV	Medium Voltage
OHL	Overhead Lines
P2P	Peer to Peer
RES	Renewable Energy Sources
RoW	Right-of-Ways
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SME	Small Medium Enterprises
TSO	Transmission System Operator
UC	Use Case
WP	Work Package

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History of changes

Date & Version	Relevant Section	Comments
V2.0 24/11/2022	APPENDIX I	Reformatted (the previously numbered as) Table 1 to be more readable and placed it in APPENDIX I as requested (see page 68).
V2.0 28/11/2022	Section 1 – Introduction	Reformatted the structure of the Introductory section to follow the other deliverables' format. Also, renamed section 1.1 into Scope of the Document, 1.2 into Relationships and Connections with BD4NRG WPs and D1.3 into Document Structure.

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Executive Summary

Deliverable D6.1 - "Pilot Operation, Engagement and M&V plan" is the referral document of Pilot Operation, Engagement and Measurement / Verification (M&V) Plan and contains the necessary information of the methodology for the evaluation of the developed tools and services during the BD4RNG implementation and the pilot demonstrators. It describes the activities that took place in the first eight months of the project of work package (WP) six, WP6 – "Pilot Requirements and Assessment" and the relevant results, focusing on creating the plan and the suggested methodologies to monitor and track the evaluation process.

The M&V plan is aiming to address and monitor the pilot related objectives and expected impacts of BD4NRG, as described in the Grant Agreement (GA) and set key performance indicators (KPIs) for each pilot demonstrator. It describes the process under which these indicators were created and the suggested method to monitor and track their evaluation during the project's lifecycle. This process was based on pilots' information regarding their main goals, the proposed use cases (UCs) and the potential beneficiaries, as identified under WP2 – "System Requirements and Specifications". This information led to the KPIs that will be used to assess the performance of the analytics services under the scope of each pilot in order to do the final verification of the pilot demonstrator. Furthermore, it also presents the timeline of the evaluation process, under the three development cycles, and the required work that will be held in between to streamline activities across all pilots. A proposed user satisfaction methodology has also been created spanning the full project's lifecycle, in alignment with the evaluation timeline to verify BD4NRG's tools and services. The M&V plan presented in this document, aims to be an exhaustive and complete approach, and sets the basis for the deployment and evaluation for the pilots' activities during the project lifetime.

Finally, it describes the initial work carried out regarding identifying pilots' infrastructure and digital technologies, as it will offer the initial assessment of the data infrastructure that will be used within the project to create the analytics services.

However, the M&V plan will take its final form on M14 (February 2022), after the 1st technology release of BD4NRG and the resulting initial evaluation, per the GA. During the period between the submission date of this deliverable (M8 – August 2021) and M14 (February 2022), the feedback gathered will be used to modify any required changes and refine possible goals and indicators. After that period, the M&V Plan will be used to ensure that all measurement procedures will follow this plan consistently.

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1 Introduction

1.1 Scope of the Document

Deliverable D6.1 - "Pilot Operation, Engagement and M&V plan" presents the framework under which pilot activities are coordinated within the project's lifetime. This framework consists of the general specifications that refers to all pilots and the specific for each pilot case.

The goal of the deliverable is to create the initial structure of the pilot operation, engagement and measurement & verification (M&V) plan, until it takes its final form on M14 (February 2022). To this end, it describes the necessary steps that have taken place until M8 (August 2021) and will be the basic structure of the final plan. This structure is based on the scope of the pilots' targets and goals under which the analytics services will be created, and taking into account the relevant stakeholders that are expected to be the main beneficiaries and set the basis for the future pilot activities that will be reported in the relevant WPs (WP7 – ""BD-4-NET" Large Scale Pilots: Increasing the Efficiency and Reliability of the Electricity Network", WP8 – ""BD-4-DER" Large Scale Pilots: Optimizing the Management of Assets (DER - Distributed Energy Resources) Connected to the Grid" and WP9 – ""BD-4-ENEF" Large Scale Pilots: De-Risking Investments in Energy Efficiency and Increasing the Efficiency and Comfort of Buildings").

The main objectives of deliverable D6.1 - "Pilot Operation, Engagement and M&V plan" is outlined as follows:

- Describe the steps and procedures for the deployment and validation of the BD4NRG tools and services in the pilot demonstrators.
- Create the M&V plan, by providing the general and specific to each pilot KPIs.
- Analyse the engagement plan for the pilots and pilot activities.

1.2 Relationships and Connections with BD4NRG WPs

As deliverable D6.1 contains the pilot operation, engagement and M&V plan, it links with several activities of BD4NRG that include pilot activities.

Specifically, it has a close connection with WP2 – "System Requirements and Specifications", as the pilot specific KPIs derive from the proposed UCs, pilot goals and main beneficiaries. It also aims to provide information regarding pilots' infrastructure and digital technologies through the developed templates, that will be used for the technical activities of WP3 – "Data Governance and Management" and the development of analytics toolbox of WP4 – "Data Modelling & Open Modular AI-based edge-level Analytics Toolbox".

Finally, it aims to act as a reference and the starting point of the baseline assessment of the pilots, which will be reported on the relevant WPs, WP7 – "BD-4-NET" Large Scale Pilots: Increasing the Efficiency and Reliability of the Electricity Network", WP8 – ""BD-4-DER" Large Scale Pilots: Optimising the Management of Assets (DER-Distributed Energy Resources) Connected to the Grid" and WP9 – ""BD-4-ENEF" Large Scale Pilots: De-Risking Investments in Energy Efficiency and Increasing the Efficiency and Comfort of Buildings".

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1.3 Document Structure

The document is organised in six different sections as follows:

Section 1 includes the objectives of the deliverable and the connection with other WPs.

Section 2 provides the general methodology of the evaluation process along with a suggested timeline, the vision and goals of the pilots and the project itself, the potential beneficiaries. It also describes possible risk factors.

Section 3 presents the M&V plan of pilots, their data infrastructure and the user satisfaction methodology.

Section 4 describes the pilot deployment plan in relation with the analytics services to be developed, and the pilot engagement plan during the project

Section 5 presents the general KPIs of the M&V plan.

Section 6 presents the pilot specific KPIs of the M&V plan.

Section 7 summarises the document and outline the next steps.

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2 General Methodology

2.1 Development Cycles

During its lifecycle, BD4NRG will base its workflow on short iterative cycles of work. This will provide continuous feedback on all activities before the final roll out and help identifying potential issues that might arise and need refinements. In this iterative process, a parallel stream of activities will take place throughout the project for testing, validating and exploiting the results of activities. This continuous integration will reflect the work being carried out, during the project in three separate phases, as described in the GA.

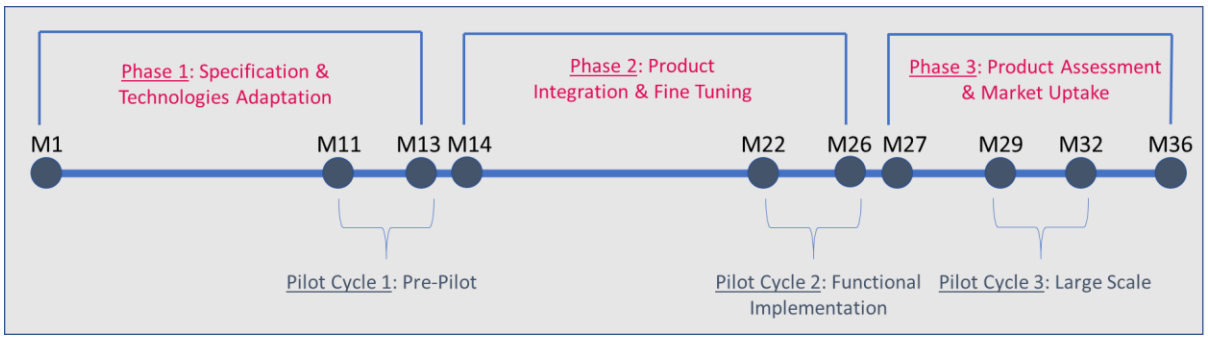

Figure 1: WP6 Timeline

Phase 1 that runs through M1 (January 2021) to M13 (January 2022), is the first phase that the early technology and asset assessment procedures will lead to preliminary validation of the pilots' deployment activities set by their specifications. During the Phase 1 the validation of the Pilot Cycle 1 (Pre-Pilot), will be held between M11 (November 2021) and M13 (January 2022) and will include the evaluation of an early data-driven experimentation, through proof-of-concepts and early technology probes based on the 1st technology release at M10 (October 2021), for a subset of pilot sites.

Phase 2 will be based on the feedback of Phase 1, and all the pilot scenarios and requirements will be refined towards the 2nd technology release at M21 (September 2022). After the 2nd technology release, the Pilot Cycle 2 (Functional Implementation) will take place between M22 (October 2022) and M26 (February 2023), with the complete BD4NRG framework to be deployed with a second pilot validation campaign.

Phase 3 is the final phase of the project, which will use the evaluation of results of Phase 2 in order to enable the refinement of components and system level technology consolidation and it will lead to the final technology release at M28 (April 2023). Between M29 (May 2023) and M32 (August 2023) the Pilot Cycle 3 (Large Scale) will take place, focused on the scalability of the outcomes, and provide the necessary benchmark to perform the business validation of the developed solutions.

Based on the three development cycles, pilot activities will carry on in parallel with the technical activities to ensure ongoing monitoring and testing of BD4NRG tools. The relevant key months, along with a brief description of the work that has been done by M8 (August 2021) and which pilot related activities need to be tracked with the key months, are presented below:

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Figure 2: WP6 Key Months

- M6: Pilot Scenarios Definition

  By M6, the initial pilot scenarios definition has been outlined and reported to the deliverable D2.1 – "Big Data Value Chain and Requirements". In these first six months of the project, for the UCs that pilots will base their activities and BD4NRG will use as demonstrators, an initial overview of the planned data to use on each pilot to create the analytics services and the digital infrastructure of each pilot have been recorded. This relevant information is explained in detail on section 3.2, and it is the starting point towards the validation of BD4NRG's tools and services, as it will be the basis of the early data-driven experimentation and will lead to the 1st Pilot Cycle.

- M8: Initial Pilot Operation, Engagement and M&V plan

  By M8, the pilot operation, engagement and M&V plan has taken its initial form and is presented on deliverable D6.1 - "Pilot Operation, Engagement and M&V plan". These activities are focused on identifying the relevant KPIs both on general level (horizontal ones for all pilots) and on pilot specific level that the M&V plan. These KPIs (explained in detail on section 5 and section 6) need to be in accordance with the BD4NRG expected impacts and the pilots expected outcomes, in order to fulfil BD4NRG's vision. The proposed pilot deployment plan (presented on section 4.1) of BD4NRG's tools and services that was created, follows an iterative process that ensures the monitoring of the maturity of each pilot and the interaction with BD4NRG solutions throughout the project.

- M10: 1st Technology Release

  BD4NRG 1st Technology Release will utilise the work carried out of the first months within WP6 – "Pilot Requirements and Assessment", by performing the early data-driven experimentation based on the pilots' data provision.

- M11-M13: Evaluation Period – 1st Pilot Cycle/Pre-Pilot

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The 1st Pilot Cycle will use as pilot demonstrators a subset of the pilots and will act as the evaluation of the 1st technological release. In this period, the most mature pilots based on the deployment plan will be selected, in order to provide meaningful feedback of the proof-of-concepts and the early technology probes. A first user satisfaction assessment (via questionnaires, more details regarding the user satisfaction methodology can be found on section 3.3) is also planned to take place on the selected pilots to provide a first feedback of the tools and services on the relevant pilot targeted stakeholders.

- M14: Final Pilot Operation, Engagement and M&V plan

  On M14, after the 1st Pilot Cycle the pilot M&V plan will take its final form, based on the gathered feedback of Pre-Pilot Phase, and the inputs of deliverables D7.1 – "Baseline Analysis Report and 'BD-4- NET' Large Scale Pilots Preparation", D8.1 – "Baseline Analysis Report and 'BD-4- DER' Large Scale Pilots Preparation" and D9.1 – "Baseline Analysis Report and 'BD-4- ENEF' Large Scale Pilots Preparation", in which the pilot specific KPIs will be finalised and the corresponding baseline assessment and target values of the KPIs are reported. After M14, all measurement procedures will follow this plan based on the deployment plan of the pilot operations.

- M15: BD4NRG Pilots Synergies, Evaluation and Feedback

  On M15, the second deliverable of WP6, D6.2 - "BD4NRG Pilots Synergies, Evaluation and Feedback - First Release" will be released. This deliverable will use as input the results of pilot activities of Pilot Cycle 1, the final M&V plan and deliverables D7.1 – "Baseline Analysis Report and 'BD-4-NET' Large Scale Pilots Preparation", D8.1 – "Baseline Analysis Report and 'BD-4- DER' Large Scale Pilots Preparation" and D9.1 – "Baseline Analysis Report and 'BD-4- ENEF' Large Scale Pilots Preparation", in order to assess the performance of the pilots and ensure that the specified KPIs are being monitored and achievable. It will also offer an overview of the potential synergies and the transferability of analytics services between pilots.

- M21: 2nd Technology Release

  BD4NRG's 2nd Technology Release will use as input the outcomes of Phase 1 and a second implementation of advanced functionalities for technological components will be released.

- M22-M26: Evaluation Period - Pilot Cycle 2/Functional Implementation

  On Pilot Cycle 2, the second validation campaign will take place. This evaluation period is expected to take place to all pilots in accordance with their deployment plan processes and will highlight the full BD4NRG framework and technology enablers at pilots' site. A second iteration of user satisfaction assessment is planned to take place, by extending the stakeholders audience to receive external validation of the tool and services of BD4NRG.

- M28: Final Technology release and BD4NRG Pilots Synergies, Evaluation and Feedback

  The BD4NRG final technology release, will use the results of Phase 2 and the Pilot Cycle 2 and deliver the final version of BD4NRG technology release.

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The third deliverable of WP6 (D6.3 - "BD4NRG Pilots Synergies, Evaluation and Feedback - Second Release) will also be released on M28. As the levels of maturity of pilots increasing, the synergies between them are expected to be clearer at this stage and the interconnections between them will be further defined in the period leading to M28. On this deliverable a detailed analysis of the pilots' evaluation will also be reported based on the Pilot Operation, Engagement and M&V plan, outlining the pilots' status.

- M29-M32: Evaluation Period - Pilot Cycle 3/Large Scale

  The Final Pilot Evaluation period of Pilot Cycle 3 will focus on the scalability of the solutions and provide the benchmark to perform the business validation. In this period, all analytics services are expected to be fully deployed and able to compliment the Large-Scale Pilot (LSP) definition by addressing all the pilots requirements, specifications and scenarios. The final user satisfaction assessment will take place in order to provide the relevant stakeholders feedback on the developed services, their scalability and its business potential.

- M36: Final Evaluation

  The final deliverable of WP6, D6.4 - "Final Evaluation, Impact Assessment and Adoption Guidelines" will be released at the end of the project (M36). In this deliverable the evaluation of BD4NRG's tools and services to the LSPs will be assessed based on the implementation, operation and execution of the requirements that have been set. It will also include the results of the three target audience workshops that are envisioned under task 6.4 - "Pilots' Validation and assessment and Stakeholders' Feedback", which are planned to take place in the final months of the project and the results of the final user assessment of Pilot Cycle 3.

2.2 Vision and Goals

As stated in the GA, "BD4NRG envisions to become the product that will revolutionise the exploitation of big data technologies and analytics in the activities and businesses related to energy, by providing a definitive framework for knowledge extraction, as well as fine-grained business intelligence services to interested stakeholders."

To reach its expected impacts on every scale of the project, several indicators will be outlined and monitored during the project's lifecycle. Objectives and impacts are defined on two levels, the consortium level, and the pilot application level. These two layers are separated by the objectives that are aiming to be met, the horizontal ones across all activities of BD4RNG and pilot specific respectively. For the consortium level, the specifications and objectives derive directly from the GA, whereas the pilot level derives from the pilot process, in which the BD4NRG tools and applications will be demonstrated in real life scenarios, different UCs and scenarios per pilot.

2.2.1 Consortium Level

At the consortium level, the general framework and the expected impacts of the project are defined by the GA. These impacts provide the general directions under which BD4NRG and the pilot demonstrators will be based on in order to fulfil the project's vision. The means of verification of these is also defined by the GA with the relevant KPIs. In this section an overview with the expected impacts is presented and on section 5 the detailed KPIs are outlined.

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- Effective integration of relevant digital technologies in the energy sector, resulting in integrated value chains and efficient business processes of the participating organisations.
- Enhancing energy asset management, increasing consumer participation and innovative network management, creating new data-driven business models and opportunities and innovative energy services.
- Contribution to increasing the use of renewable energy and increased energy efficiency based on optimised energy asset management offering access to cheaper and sustainable energy for energy consumers and maximising social welfare.
- New data driven paradigms for energy management systems able to deal with increased complexity of the energy systems.
- Improving availability of big data and big data management & analysis facilities for real life scale research, simulation and test purposes.
- Increased number of platforms, applications, business processes and innovative business models validated via largescale piloting.

2.2.2 Pilot Level

Regarding the pilot level, apart from the expected impacts, UCs requirements and specific gaols needs to be met as well, as reported on deliverable D2.1 – "Big Data Value Chain and Requirements". These goals need to be aligned with the general vision of BD4NRG and support the expected impacts of the project. Hence, they set the basis of the pilot framework under which the evaluation of both BD4NRG tools and services to pilot demonstrators and pilots' applications will take place. In APPENDIX I, a detailed description of the specific goals set by each pilot as recorded in the first months of the project are presented.

The goals set by pilots in each of the UCs, are the main identifiers for the monitoring and evaluation of the performance. To this end, a set of KPIs per UC has been identified (presented in detail in section 6) in order to monitor and track the progress of each pilot. This process will help the iteratives cycles of work, as from the early stages of the project the expected outcomes and the means of verifications are identified and ensures that the outcomes of BD4NRG services to pilot demonstrators will accomplish to fulfil its vision and the expected impacts.

2.3 Stakeholders

The BD4NRG project will engage a wide range of stakeholders, through both pilot demonstrators and the envisioned external audience which will exploit its outcomes. The stakeholders' interests cover the full spectrum of BD4NRG framework and activities, and the aim is for BD4NRG's tools and services to be able to satisfy the criteria which will provide added value to this diverse set.

The process of identifying the potential target groups of stakeholders takes place in a horizontal level of the project, due to the fact that BD4NRG will offer a vast amount of technological, scientific and business outcomes. As the project advances, these target groups will be specifically identified, once the outcomes will become clearer, and their potential reach will be fully defined.

The start of this process on the pilot demonstrators side starts with the process of the pilot actors' identification that will benefit from the proposed UCs and the analytics services. Since pilot

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demonstrators are consisted of partners that belong in the stakeholder's target groups, they provide a baseline of the applicability of the solutions and act as the first beneficiaries of the services that will be developed. As the services will take their final form as the project advances, BD4NRG will validate the suggested solutions and can gain valuable feedback in order to extend its audience and target external stakeholders that will be able to exploit the outcomes.

The goal of this process is to exploit the results to the envisioned stakeholders effectively based on the main beneficiaries (pilot partners) and the UCs' identified actors to validate the BD4NRG tools and services.

2.3.1 BD4NRG Stakeholders

The envisioned target groups are presented in the table below:

Table 1: BD4NRG Stakeholders

Target Group	Description
EPES Value Chain Stakeholders	Generators, suppliers, TSOs, DSOs, aggregators, consumers (municipalities, building operators, local energy communities, etc.), suppliers, ESCOs
IT Industry Players & SMEs	IT companies, web entrepreneurs, software engineers of solutions for big data and energy domains
Equipment Manufacture	Industrial Manufacturers of smart energy grid devices (e.g., smart meters, transformers, breakers, automation devices)
Industry Associations & Technology Clusters	European initiatives and clusters (like BDVA, IDSA, AIOTI and FIWARE, ETIPSNET), research communities, associations, federations (like IMS, EFFRA, IFIP, IEEE, NEM)
Research & Academia	Individuals engaged in research initiatives and/or working in research/academic institutes
Investors	Banks, RES/EE Investors/Venture capitalists, Crowdsourcing platforms
Policy Makers & Standardisation Organisations	Policymakers at any level like EC Directorates and Units, Ministries and Governments, Regulatory Agencies, Standardisation Organisations (CEN, ISO, ETSI, etc.)
General Public	Civil society representatives, general public and anyone interested in the project

Consortium partners are strategically selected from the pool of the envisioned stakeholders and are acting as the main beneficiaries of BD4NRG's tools and services upon which they will be validated during the project's lifecycle. Below the partners are presented in terms of both their operational sector and the target group connection:

- Large ICT Companies (ENG, ATOS, ED), leading on advanced ICT and big data technologies (ENG and ATOS are founding members of BDVA).

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- A large variety of EPES stakeholders covering the full energy value chain:
  - Power Network Operators, including two TSOs (REN, ELES) and three DSOs (ASM, EKL, OEDAS)
  - The European Network of Transmission System Operators (ENTSO-E) Association; Power Market Operators (BORZEN)
  - Independent Aggregators (CENTRICA)
  - Distributed Energy Resource (DER) Operators (ENELX, ENERC)
  - ESCOs and Financing Institutions (VEOLIA, LEIF)
  - Municipalities (AJSCV).
- Leading Research & Academy Institutions (RWTH, TNO, UNIWA, UNILJ, NTUA, IMEC, CARTIF, UNINOVA, RDN).
- EU-level foundations/associations in the domain of ICT/cloud (IDSA, FIWARE, EGI)
- Leading-edge SMEs focused on weather forecasting and analytics services (UBIMET), geographical data integration (TS), legal, privacy and ethical implications and social acceptance of big data technologies (ELEX), e-mobility and EVs recharging management (EMOT), data-driven automated energy management (CS), marketing campaigns and awareness raising (HOLISTIC).

Table 2: BD4NRG Partners

Target Group	Partner
ICT Service and Tech Providers - Industrial Partner (including SMEs)	ENG, ED, ATOS
EPES Stakeholders	ELES, REN, ASM, EKL, OEDAS, CENTRICA, ENELX, VEOLIA, AJSCV, LEIF, ENERC, RDN, BORZEN
Foundations and Associations	ENTSO-E, FIWARE, IDSA, EGI
Research Institutions	RWTH, TNO, UNIWA, UNILJ, NTUA, IMEC, CARTIF, UNINOVA
Third Party SMEs and Service Offering	CS, ELEX, HOLISTIC, CN, TS, UBIMET, EMOT

2.3.2 Pilot Actors Process

BD4NRG will demonstrate its tools and services in several different scenarios, through the LSPs. Under activities of WP2 – "System Requirements and Specifications", a personalisation process was created by defining UCs, usage scenarios and actors per pilot. The personalisation process will help to specify the usage and the added value of the services, thus enabling upscaling the solutions in an effective manner by targeting the relevant audience.

The identified actors are a subset of the stakeholders described on 2.3.1 and will be the expected beneficiaries per usage scenario and UC per pilot. Hence, the measurement and verification plan, the pilot operation and deployment plan and the monitoring and evaluation progress throughout the project will use this personalisation process as reference and benchmarking.

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Further details regarding the pilot actors can be found on deliverable D2.1 – "Big Data Value Chain and Requirements".

Table 3: Pilot main beneficiaries and actors

Large Scale Pilot	Main Beneficiary	Identified Actors
LSP1	TSO	Asset Management Division of TSO Protection Engineers
LSP2	TSO	Internal TSO departments: system operation, system maintenance, asset management DSOs HV-grid connected consumers and producers of electricity
LSP3	DSO	EV managers Technical providers Manufacturers
LSP4	DSO	DSO
LSP5	Aggregators	Residential Consumers DSO/TSO
LSP6	DSO Grid Users Market Operators	Residential customers RES producers Independent aggregator Market operators Independent aggregators Residential customers RES producers Suppliers
LSP7	Aggregators	ESCOs Universities
LSP8	DSO	Island municipalities End-customers Local energy communities and aggregators Private RES actors/prosumers
LSP9	RES Operators Grid operators Aggregators Energy suppliers	National Weather institute Grid Operator Weather services providers Operation and Maintenance services provider EPES stakeholders: Suppliers, aggregators, DSO, TSO, ESCOs Electricity Map Open-Source provider
LSP10	ESCOs	Data provider Public entities Technology developers

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Large Scale Pilot	Main Beneficiary	Identified Actors
LSP11	Building owners	ESCOs Data Providers Public entities Technology developers Building users
LSP12	Investors	ESCOs Governmental institutions Financiers Project developers Building owners

2.4 Risk Factors during Progress Monitoring

The proposed Pilot Operation, Engagement and M&V plan will take its final form on M14 (February 2022) and after its finalisation, it must be ensured that the progress will be tracked based on it. Up to date, the suggested plan is almost to its final form. Modifications and refinements are expected to take place as the early data-driven experimentation of the 1st Technology Release and the Pre-Pilot Cycle evaluation period, will offer valuable feedback to pilot activities. The general framework is defined and the identification of the indicators that will be used (KPIs) are as extensive as possible in this early stage. However, due to the close connection of WP6 with WP7 – "BD-4-NET" Large Scale Pilots: Increasing the Efficiency and Reliability of the Electricity Network", WP8 – ""BD-4-DER" Large Scale Pilots: Optimising the Management of Assets (DER-Distributed Energy Resources) Connected to the Grid" and WP9 – ""BD-4-ENEF" Large Scale Pilots: De-Risking Investments in Energy Efficiency and Increasing the Efficiency and Comfort of Buildings", pilot partners that wish to specify their activities can do so in deliverables D7.1 – "Baseline Analysis Report and 'BD-4- NET' Large Scale Pilots Preparation", D8.1 – "Baseline Analysis Report and 'BD-4- DER' Large Scale Pilots Preparation" and D9.1 – "Baseline Analysis Report and 'BD-4- ENEF' Large Scale Pilots Preparation", in which the baseline assessment report and targets will be reported for each pilot. Upon completion of the Pre-Pilot Cycle, the M&V plan is expected to take its final form and cover all aspects of pilot activities.

Two main issues have been identified as potential risk factors:

- The first risk factor is based on the workflow structure. At the early stages of the project different levels of maturity will be faced towards pilot demonstrators and deployment. In order to validate BD4NRG's tools and services, the technology enablers must be aligned with pilots' activities so as to avoid experiencing time delays during the early data-driven experimentation, resulting in possible rollbacks. The reverse reasoning is also a risk factor, as insufficient or ineffective pilot support in technical implementation could lead to delays in creating the technical aspects of BD4NRG platform.

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- The second risk factor is the potential constraints in activities by limitations posed due to COVID-19 pandemic crisis. Although the project will end its activities in December of 2023, the iterative process that is followed requires constant feedback between BD4NRG and its target groups which consequently affects its progress. At this stage, this risk factor is more evident at the user satisfaction methodology (section 3.3)and specifically in its first phase during the Pre-Pilot Cycle. In regular times, the feedback would be also asked to external audience, as first indicators. With limited mobility, it is proposed to keep the first phase of user satisfaction internally, for the main beneficiaries and suggested pilot actors of the selected pilots, which will be used for the early data-driven implementation, in order for the work progress to be carried through and not deviate from the iterative workflow processes. Furthermore, workshops and demonstration of BD4NRG are planned to take place towards the end of the project. These issues will be dealt with accordingly, as time approaches and there will be a clearer view of the situation regarding mobility limitations at that time.

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3 Measurement and Verification Plan

3.1 BD4NRG General Context

BD4NRG will validate its tools and services in several ways, with a methodology that covers all the aspects of the project and its expected outcomes. The methodology is covering the context of the M&V plan and will demonstrate the results of BD4NRG and their potential added value as envisioned onto the pilot demonstrators.

More specifically, the services to be developed are being tracked with the KPIs set in both general level (across all pilots) and the pilot specific KPIs. The general KPIs are common for all pilots and the specific KPIs are unique for each pilot, under their proposed UCs and usage scenarios.

The way which the general context of the measurement and verification plan resulting in the general KPIs for the pilots has been created, is expected to offer an efficient tracking and monitoring progress for all BD4NRG partners, that will use as input and reach the objectives of the respective WPs. Information such as data provision, data variety, pilot infrastructure, analytics techniques, are common as reporting information for all pilots, and consequently they were used as the framework for the general KPIs for smooth flow of information between WPs.

The pilot specific KPIs are the envisioned means of validation for pilot demonstrators, specific on each pilot and will measure the effectiveness of the demonstrators based on their suggested services and scenarios. BD4NRG consists of 12 pilot demonstrators under three main pillars, “BD-4-NET”, which are aiming to increase the efficiency and reliability of the electricity network, “BD-4-DER”, which are aiming to optimise the management of distributed energy resources (RES) connected to the grid and “BD-4-ENEF”, which are aiming to de-risk investments in energy efficiency and increasing the efficiency and comfort of buildings. Furthermore, in each pillar, the LSPs will develop different type of services aiming to address different problems. It is evident that it is not convenient to apply a holistic approach, as the indicators varies to each pilot within every pillar. Hence, the pilot specific KPIs were created with the view to have an efficient and successful way to measure pilots’ performance.

Following the iterative process applied for the project regarding its activities and the constant feedback between project partners and stakeholders, a verification process tailored to the user satisfaction is planned. The user satisfaction methodology is aligned with the three development cycles and pilot validation periods and is aiming to provide insights regarding BD4NRG’s tools and services. This methodology is envisioned to incorporate elements of different WPs (mainly regarding the technical capabilities of the toolbox and its interactions with the users), as it will act as the external validation for the project’s outcomes.

In this section, the abovementioned general context and the user satisfaction methodology is described. The detailed general KPIs can be found on section 5and the pilot specific KPIs on section 6.

3.2 Infrastructure and Digital Technologies

As BD4NRG is a data-driven project, it is crucial to identify the needs of its expected users and create valuable tools and services which will cater to them. Pilot demonstrators offer the baseline approach and the first infrastructure in order for technology enablers to create the necessary tools and services. To this end, at an early level of the project an assessment of the pilots’ infrastructure and digital technologies was gathered based on three documents:

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- Data Gathering Template: A template which is used to incorporate the data provision information from pilots and relevant information. This template sets the reference of the data availability that needs to be reported both on volume and variety for technical WPs and service developments.
- Analytics Services Template: A template which contains a preliminary view of the services to be developed in each pilot. Information regarding the scope of the services, data requirements, analytic techniques and other related information were gathered for each pilot.
- Pilot Infrastructure Template: A template which includes technical information regarding the pilot's infrastructure. Information regarding the digital infrastructures such as communication protocols, existing data models that are being in use and connectivity interfaces was asked to pilot partners with a view to use this information complimentary to technical WPs.

These templates were created with respect of the BD4NRG general context of the M&V plan, thus containing the necessary information to track and monitor the general KPIs. They also pinpoint horizontal character of WP6, acting as the communication point between technical WPs and pilot demonstrators, as they contain information that will help activities in different WPs. In that way it ensures the transfer of knowledge within the consortium and minimising the risk of creating solutions that are not applicable in the demonstrators. All three templates can be found in the respective appendixes (APPENDIX II, APPENDIX III and APPENDIX IV).

In this deliverable, the process of the M&V context and plan is the main focus, thus the detailed information of these templates would be found in the relevant technical deliverables of WP3 – "Data Governance and Management" and WP4 – "Data Modelling & Open Modular AI-based edge-level Analytics Toolbox", where technical/software components will be reported, as well as on deliverables of WP7 – "BD-4-NET" Large Scale Pilots: Increasing the Efficiency and Reliability of the Electricity Network", WP8 – ""BD-4-DER" Large Scale Pilots: Optimizing the Management of Assets (DER - Distributed Energy Resources) Connected to the Grid" and WP9 – ""BD-4-ENEF" Large Scale Pilots: De-Risking Investments in Energy Efficiency and Increasing the Efficiency and Comfort of Buildings", where the pilot documentation will be reported. Hence, the focus is on the creation of the general KPIs that derived from this process and as mentioned above, can be found in detail in section 5.

3.3 User Satisfaction

The user satisfaction methodology will follow the development cycles (Figure 1) in order to align with the technology releases and maturity. Under this context, the feedback gathered per cycle can be used for efficient re-designing with the end users' perspective and feedback taken under consideration. Three phases of user satisfaction are envisioned during the pilot validation cycles (Pre-Pilot, Full-Pilot and Final Validation). The methodology aims to provide external validation of BD4NRG's tools and services by the target audience and envisioned stakeholders regarding its applicability and potential added value.

The methodology will use specific questionnaires and workshops of live demonstrations (under tasks T6.3 – "Pilots' synergies analysis and collaborations" and T6.4 – "Pilots' Validation and assessment and Stakeholders' Feedback") aiming gain feedback of the project's results. The questionnaires will be created in accordance with the level of maturity of the project, both in technical level and pilot application level, and the requirements which have been identified at the start of the project. Input for the creation of the questionnaires will be provided from multiple WPs, to assess the effectiveness,

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usefulness and accessibility of the results among others. To this end, user satisfaction methodology will be consisted of both general questions regarding the BD4NRG solutions and specific questions per pilot regarding the services to be deployed.

General questions are but not limited to:

- How would you rate the experience of BD4NRG's services?
- How would you rate the service's efficiency?
- To what extent the proposed service is innovative? Have you ever encountered a similar service?
- How would you rate the easiness of use of the service?
- Is the service easy to access?
- To what extent does the service meets your expectations?

These types of questions are indicative of the way the questionnaire will be structured and will be further defined so as a unified framework to be created across all services. Moreover, questions that are specified to the services directly and assess the user's satisfaction per service will also be included in the questionnaires. These questions will be developed in collaboration with the pilot partners and service providers, aiming to address the pilot unique requirements and expected results.

As BD4NRG foresees workshops and live demonstrations, participants involvement is expected. In such cases, all the necessary procedures that maintain privacy, confidentiality, informed participation, compliance with national and EU legislation will take place (e.g., information sheets and informed consent forms). The questions of the User Satisfaction questionnaires will be in line with all the ethical requirements of WP11 – "Ethics requirements" via the relevant deliverable D11.1 - "H-POPD-Requirement No. 1", and upon consultation within the consortium. The activities regarding the compliance with the ethical issues when human activity is involved will be reported on future WP6 deliverables, after the questionnaires will be created and the workshops will take place.

The timeline of the user satisfaction methodology is the following:

- On M11 (November 2021), the process of identifying the pilots that will be used for the Pre-Pilot Cycle will take place. After the identification, the questionnaires of the first iteration will be created for this set of pilots. Cooperation with the technical WPs will be held in order to define the general questions for the 1st technology release. This iteration will be used to gain feedback of the early data-driven experimentation and the first services' results, based on the identified UCs and the expected goals of these pilots.
- On M13 (January 2022), the questionnaires will be handed to the first set of pilot actors. This process is expected to take place internally within pilot partners, in order to identify the usefulness of the approach and the specifications fulfilment.
- Between M22-M26 (October 2022-February 2023) within the Full Pilot Cycle, the same approach of user satisfaction methodology will take place for all pilot demonstrators. Upon consultation with the pilots, the technical WPs, the questionnaires will be refined and will reflect the final M&V plan. In this way, the process will be more advanced towards the pilot demonstrators and include refined general questions regarding BD4NRG tools after the implementation of the 2nd technology release.

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- Between M29-M32 (May 2023-August 2023), the final Pilot Evaluation will take place along with the final stage of the user satisfaction methodology. A final round of questionnaires will be handed to the identified beneficiaries for the tools and services. The process of creating the questionnaires will be similar with the two previous cycles of the user satisfaction methodology. In the final evaluation period, 3 workshops are also envisioned to take place under task 6.4 – "Pilots' Validation and assessment and Stakeholders' Feedback", where live demonstration will take place to the targeted audience of BD4NRG. Although it is possible for the workshops to be held in a previous cycle too, at this early stage of the project it is considered to be pushed towards the end of the project, addressing potential mobility limitation and ensuring technological maturity of BD4NRG tools and services.

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4 Pilot Operation & Engagement Plan

BD4NRG's pilot operation & engagement plan describes how the developed tools and services of BD4NRG will be deployed in the pilot demonstrators. As BD4NRG includes a diverse set of partners which covers a wide range of the EPES value chain, the need to efficiently track and monitor the activities during the project is considered necessary. Thus, a holistic methodology regarding the operation plan, that can be applied to all pilots and increase their involvement throughout the project is suggested. This approach is planning to increase the engagement of the pilots by manifesting a rigorous process of iterative cycles for each pilot demonstrator, which will ensure the realisation of BD4NRG through discrete steps.

4.1 Pilot Deployment Plan

The deployment plan outlines the monitoring methodology to be followed, in order to track the progress of the analytics services related to the pilot demonstrators during the project's lifecycle. It also provides a comprehensive process, which will allow the pilot implementation and validation activities to be streamlined throughout the project.

The deployment plan will follow an iterative process of three cycles. However as opposed to the development cycles, this process has been created to evaluate the readiness of the specified functions and developed processes of the analytics services of BD4NRG. In this way, it will be ensured that a homogeneous tracking process across all pilots will take place and will help to identify potential risk factors of the pilots' operations, independently of the timeline of the project. The deployment plan along with the development cycles will offer the ability to assess in every step of the project, how the analytics services are progressing and if they are meeting the timeline deadlines.

Each cycle of the deployment plan is part of an iterative process which is aiming to provide meaningful inputs to the next one. The iterative process of the deployment plan will help making the tools of BD4NRG available for the pilot demonstrators. It will also provide an efficient method through constant feedback of the status of the services, to the evaluation of the pilot specific KPIs and how the goals that have been set are met by the developed services.

For the incremental strategy to be fruitful, the proposal is to have a timely and precise documentation of the steps and considerations taken in account on each stage of development. Each UC identified by pilots needs to be mapped to an analytics service, so the criteria and approvals have to be checked in each of the iterations. To this end, the status of an analytics service needs to be documented in order to make necessary adjustments based on the needs of the UCs of the pilot partners.

The definition of each stage is as follows:

Basic Pilot Stage (BPS) corresponds to the 1st technology release of the platform services. This is the first iteration that will set the basis of each service. As described in section 2.1, during the Pre-Pilot Cycle phase the pilots that will the more mature will be selected for the early data-driven experimentation, so as to allow seamless integration of different parts of the platform in future releases. The early data-driven experimentation and consequently the Pre-Pilot Cycle phase is aligned with the BPS, so to provide a benchmark for all pilots. It is expected that all pilots will reach the BPS within few months' time after the Pre-Pilot Cycle phase, in order to be ready for the second phase of the development cycles, the Full-Pilot Cycle.

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Intermediate Pilot Stage (IPS) corresponds with the 2nd technology release. Pilots that reach the IPS will be ready to evaluate the different hardware devices and infrastructure that is required by each, and their behaviour when integrated into the BD4NRG platform.

Advanced Pilot Stage (APS) corresponds to the first stable version of the platform services and will effectively allow the usage of services by third party users.

The handout of stage to the next will be as follows: BPS will give an input to IPS regarding urgent matters that need to be addressed and feature requests that may have been noted during the first testing stages. IPS will outline the pathways to address the homogenisation of the requirements and infrastructure of the different pilots and to recommend optimisation for both algorithms and infrastructure. APS will test the ability to withstand real-life needs and outline suggestions for future developments.

The proposal for the deployment tracking, as part of task T6.2 – "Pilot monitoring and coordination" is a live document presented in the following table, which contents will be changed and kept aligned with the development of the analytics services.

Table 4: Pilot Deployment Information

Topic	Sub-topic	Description
Overview	Goals and objectives	Description of the scope of the service, the stakeholders and beneficiaries for the current stage
	Use Case summary	Description of the identified UC of the service
	Action Plan	List of the mandatory activities for the iteration cycle
Requirements	Assumptions	Description of the expected results when the iteration cycle is over
	Dependencies	Description of interactions with other developed services or components (or pre-requisites)
	Risks	Description of the most likely situations or factors that may limit the functions or prevent the deployment of the service
Readiness	Deployment diagram	Summary of the necessary steps for deployment
	Deployment preparation	Description of the requirements for the components and the underlying infrastructure
	Deployment assessment	Assessment of the completeness of the preparation and the mitigation of

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Topic	Sub-topic	Description
		the possible identified risks
Data Handling	Data Population	Description of the process for populating the databases required for the operation of the services
	Algorithm Training	Description of procedures for ML/AI training with the relevant datasets, include validation mechanisms
Activities	Previous cycle	Summary of the achievements and main actions of previous stages and the identified next steps
	Current cycle	Summary of the main actions of the current stage, and how they fulfil the recommendations of the previous iteration cycle
	Future cycle	Summary of next steps and what needs to be achieved by the next cycle for improvements, optimisations or refinement (if identified)
Documentation	Training documents	Creation of documents that explain the main functionalities of the service and how to use it
	Developer documents	Creation of documents that extensively covers the main parts of the service, and facilitates the integration of new services or derivative works
	Operation and Maintenance	Creation of documents that covers the procedures for usage, start and restart of the services

The deployment plan will serve as the reference point for each pilot demonstrator. An exhaustive description of the necessary information is contained in Table 4, that will allow tracking and monitoring the process of the analytics services' development. The deployment plan offers a baseline overview on how the services can be rolled out, as a general framework for all pilots and includes all the information that is considered to be needed for a smooth and complete deployment process.

However, changes could be made as the project activities are progressing, in order to efficiently address different needs and potential issues for the pilot demonstrators. To this end, the document will be continuously revised, aiming to compliment pilot activities during the development of the analytics services.

A final note for the deployment plan is, that it was created with the view to be the reference document for successful implementation of WP7 – ""BD-4-NET" Large Scale Pilots: Increasing the Efficiency and

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Reliability of the Electricity Network", WP8 – ""BD-4-DER" Large Scale Pilots: Optimizing the Management of Assets (DER - Distributed Energy Resources) Connected to the Grid" and WP9 – ""BD-4-ENEF" Large Scale Pilots: De-Risking Investments in Energy Efficiency and Increasing the Efficiency and Comfort of Buildings" and more specifically for the deliverables that contain each pilot documentation. By following a consistent plan from the early stages of the project, keeping up to date the relevant information of pilot activities and the respective analytics services based on the iterative process, will ensure that the outcomes through pilot activities will maintain high quality and the monitoring process under task T6.2 – "Pilot monitoring and coordination" will be highly effective.

4.2 Pilot Engagement Plan

The pilot engagement plan aims to specify the way that pilot partners get involved within the project.

For the first months of the project the involvement of the pilot partners (under task T6.2 – "Pilot monitoring and coordination"), was mainly to identify the specific UCs, setting the requirements and gathering the initial data and information for the deployment of the analytics services. It consisted of communications via emails, WP6 online meetings, bilateral online meetings with pilots and WP group meetings with pilots of under the same pillar ("BD-4-NET", "BD-4-DER" and "BD-4-ENEF")

In order to efficiently manage the coordination of pilot activities, the focus was on WPs meetings where pilots of "BD-4-NET" pillar (under WP7 – ""BD-4-NET" Large Scale Pilots: Increasing the Efficiency and Reliability of the Electricity Network"), "BD-4-DER" pillar (under WP8 – ""BD-4-DER" Large Scale Pilots: Optimizing the Management of Assets (DER - Distributed Energy Resources) Connected to the Grid") and "BD-4-ENEF" pillar (under WP9 – ""BD-4-ENEF" Large Scale Pilots: De-Risking Investments in Energy Efficiency and Increasing the Efficiency and Comfort of Buildings"), were grouped together to address their specific needs under the three main pillars. In that way, the process of exchanging initial information regarding their activities, the creation of the M&V plan, the pilot specific KPIs and the input regarding the baseline assessment of pilots (which will be reported on deliverables D7.1 – "Baseline Analysis Report and 'BD-4-NET' Large Scale Pilots Preparation", D8.1 – "Baseline Analysis Report and 'BD-4- DER' Large Scale Pilots Preparation" and D9.1 – "Baseline Analysis Report and 'BD-4- ENEF' Large Scale Pilots Preparation") was dedicated for each pillar. This process will continue to take place until the baseline assessment reports in the above deliverables is submitted.

After this period, the WP group meetings of pilots under the same pillar will continue to take place, to ensure the ongoing monitoring of pilots under the same pillar, the frequency of which will be decided by the relevant WP leaders. These meeting will aim to:

- Track the progress of each pilot
- Ensure that activities are within the timeline of the project
- Identify potential synergies between pilots
- Examine issues that may arise
- Keep the engagement of pilots with the BD4NRG project

As the Pilot Deployment Plan will be rolled out and pilot activities will start to be aligned in terms of time, WP6 meetings will take place once a month in order to track the process of all pilots of BD4NRG. In that way the potential synergies between pilots, common issues and the overall assessment of BD4NRG's tools and services into pilot demonstrators will be monitored. These meetings will be held

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once a month and will be coordinated by NTUA, as the single contact point for managing and monitoring all demonstration activities, under task 6.2 – “Pilot monitoring and coordination”.

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5 General KPIs

The general KPIs are the main means of validation of the achievement of the objectives and expected impacts of the project, as reflected in the GA. They will offer a framework across all pilots, with information that needs to be horizontally tracked and monitored throughout the project, as described in section 3.1 and section 3.2. The evaluation of the general KPIs is predicted to be evolving while pilot partners help to shape each one of the goals to its final form, both fitting the specific needs of the partner and the ambitions of the project.

Table 5 presents the general KPIs, with the definition of the considerations to be made during the evaluation of the performance of the solutions that are developed in the project.

Table 5: General KPIs

KPI	Definition	Target
G01: Seamless and smooth data transition from different types of sensors	The different type of sensors that will be used to collect data.	15
G02: Seamless and smooth data transition from different types of data resources	The different type of data resources that will transmit data to the BD4NRG platform.	7
G03: Resources	The number of resources used from the data sources.	At least 200
G04: Type of data sources	The number of the different data sources to be used in BD4NRG.	At least 60
G05: Identification and interoperability with well-known open data sources	The number of open-source data sources that will be used in BD4NRG.	At least 5
G06: Datasets used	The number of datasets that will be used to develop the analytics services of BD4NRG.	At least 10000
G07: Digital Technologies integrated in the energy system	The number of digital technologies after the development of the analytics services that can be integrated in the energy system.	11
G08: Big data availability for real life research	The amount of data that will be used overall in BD4NRG.	Over 350TB

These general KPIs reflect the goals that have been set for BD4NRG as per the GA and will be tracked throughout the project's lifecycle. The process to reach the values of the KPIs is horizontal for the project. The first step for this, is to consider the pilot demonstrator capability to contribute on these indicators, but the process is not limited to the pilots. As the BD4NRG platform is being built, its modularity will offer the ability to include third party solutions that will also contribute on reaching

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the set values of the KPIs. To this end, the pilots' contribution will be monitored based on the templates that have been created and presented in section 3.2 and the annex (APPENDIX II, APPENDIX III and APPENDIX IV).

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6 Pilot Specific KPIs

As described on section 3.1, pilot specific KPIs are the envisioned means of validation for pilot demonstrators, unique on each pilot and will measure the effectiveness of the demonstrators based on their suggested services and scenarios.

The process of creating the pilot specific KPIs, was based on their UCs, the pilot goals and the pilot actors and beneficiaries, and it is aiming to specify each analytic service in order to be able to monitor their performance and facilitate any necessary action in case of underperformance.

Further than the pilot specific KPIs, there are several indicators deriving from business objectives and the expected impacts of the project as described in the GA, that need to be measured to the pilot level or are defined by pilot activities but are more horizontal to the project, and their target has been set from the GA. Those KPIs are split in three categories in order to be tracked efficiently during the project, the **B**usiness **O**bjectives (BO), the **E**xpected **I**mpacts (EI), and the **H**orizontal Expected **I**mpacts (HEI) KPIs. In the following tables the name of the KPIs, their definition and the target per the GA are presented.

Business Objectives refers to the specific objectives that have been set in the GA to validate the solutions of BD4NRG from a business perspective. The BO KPIs can be measured on pilot level; the results of the proposed services to be developed will measure these KPIs as means of validation. Under the activities of task T6.1 – "Pilot planning, requirements and KPIs" and task T6.2 – "Pilot monitoring and coordination", a process of identifying the specific pilots that can measure the BO KPIs has taken place. This process resulted on identifying the BO KPIs that can be measured either directly (i.e., the KPI is a mean of validation specifically for the proposed pilot UC) or indirectly (i.e., the KPI can be measured as a result of a pilot specific KPI). Table 6 presents the KPIs definitions, the targets as per the GA and the pilots that can measure the BO KPIs.

Table 6: Business Objectives KPIs

KPI	Definition	Target
B01: CAIDI	The Consumer Average Interruption Duration Index (CAIDI): Average interruption time per consumer affected by the interruption per year	20% improvement
BO2: SAIDI	The System Average Interruption Duration Index (SAIDI): the number of interruptions per consumer per year	20% improvement
BO3: SAIFI	The System Average Interruption Frequency Index (SAIFI): the average time of interruptions per consumer per year	20% improvement
B04: DER flexibility	Optimised management of behind-the-meter DERs assets connected to the grid measured through an increased share of flexibility mobilised against the contracted one, as	25% improvement

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KPI	Definition	Target
	consequence of non-grid-owned assets predictive maintenance analytics combined with increasing end user participation reliability	
B05: Building comfort conditions	Increase of thermal comfort	30% improvement
B06: EPC gap reduction	EPC gap reduction between predicted and actual energy efficiency performance	20% improvement
B07: Energy efficiency investment De-risking	Improvement of investment energy de-risking from calculation related to predicted and actual energy consumption	20% improvement

Horizontal Expected Impacts KPIs are KPIs that derive from the expected impacts of BD4NRG as described in the GA. They are grouped separately, as their tracking need to be done on a horizontal scale throughout the project's lifetime and cannot be assigned to specific pilots. However, as they are part of the expected impacts they are reported under the same category for consistency. Table 7 presents the EIH KPIs:

Table 7: Horizontal Expected Impacts KPIs

KPI	Definition	Target
HEI01: Pilot Demonstrators	Number of pilots through which the BD4NRG technologies are integrated	12
HEI02: Improvement of business operation for power network operators, Aggregators/Flexibility Providers, ESCOs	Aggregated KPI validating performance based on KPIs BO1, BO2, BO3, BO4, BO5, B06, G03 and G06	-
HEI03: Platforms, applications, business processes and innovative business models	Potential number of platforms, applications, business processes and innovative business models validated via large-scale piloting	30

Further than these three horizontal KPIs, under the expected impacts of the project, there are six more KPIs (Expected Impacts) can be measured directly or indirectly on pilot level. The same process as for BO KPIs for identifying which pilots can use these KPIs has taken place. In Table 8 the definition, the target per the GA and the pilots that can use the KPIs as a mean of validation for their proposed services are presented.

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Table 8: Expected Impacts KPIs

KPI	Definition	Target
EI01: Cost of asset maintenance and management	Reduction of annual cost for asset maintenance and management	30% reduction
EI02: Consumers' flexibility assets participating to DER	Increase of the consumers flexibility assets, as measure of consumer participation	25% increase
EI03: Reduced gap between contracted and activated flexibility as combined KPI to measure optimised asset management and consumer participation	Combined KPI to measure optimised asset management (B04) and consumer participation (EI04)	50% increase
EI04: Network management improvement	Improvement of network management through reduced gap between predicted and metered network loads	20% improvement
EI05: Use of renewable energy	Amount of RES-based generated energy integrated in the grid network by leveraging on predictive load and generation forecasting	30% increase
EI06: Energy efficiency increase	Increased energy efficiency measured as energy saving based on predictive consumption forecasting and comfort forecast	25% increase

The BO and EI KPIs are the specific indicators that will be tracked, measured and evaluated by different pilot demonstrators during the project's lifecycle, based on their specific applications and UCs, either directly or indirectly. The HEI KPIs will be tracked on a horizontal level and more specifically HEI02 and HEI03 will be validated in a later stage of the project, as they require advancements in the activities in order to be assessed.

At this initial stage, the identification of the BO and EI KPIs for the pilot demonstrators has been conducted for efficient monitoring and assessment and can be found on the next sections. They are reported in pilots where can be evaluated by their UCs. During the next months of the project, as the baseline assessment of the pilots (under WP7 – ""BD-4-NET" Large Scale Pilots: Increasing the Efficiency and Reliability of the Electricity Network", WP8 – ""BD-4-DER" Large Scale Pilots: Optimizing the Management of Assets (DER - Distributed Energy Resources) Connected to the Grid" and WP9 – ""BD-4-ENEF" Large Scale Pilots: De-Risking Investments in Energy Efficiency and Increasing the Efficiency and Comfort of Buildings" to be reported on deliverables D7.1 – "Baseline Analysis Report and 'BD-4-NET' Large Scale Pilots Preparation", D8.1 – "Baseline Analysis Report and 'BD-4- DER' Large Scale Pilots Preparation" and D9.1 – "Baseline Analysis Report and 'BD-4- ENEF' Large Scale Pilots Preparation") and the early data driven experimentation (with the resulting Pilot Cycle 1) will take place, the final specification of the KPIs, the targets for each one at pilot level and any possible

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refinements will be addressed. These activities will lead into the final M&V plan, on M14 (February 2022) as per the GA and any updates regarding the plan will be reported on deliverable D6.2 – "BD4NRG Pilots Synergies, Evaluation and Feedback - First Release" on M15 (March 2022).

In the following sections, the KPIs identified per each pilot demonstrator and UC are presented, along with the proposed formula to measure them, their units and an indicative target, where applicable. The UCs identified are also brief presented to showcase how the KPIs relates to them and the expected goals once the analytics services are developed.

The notation of the pilot KPIs for identification is the following:

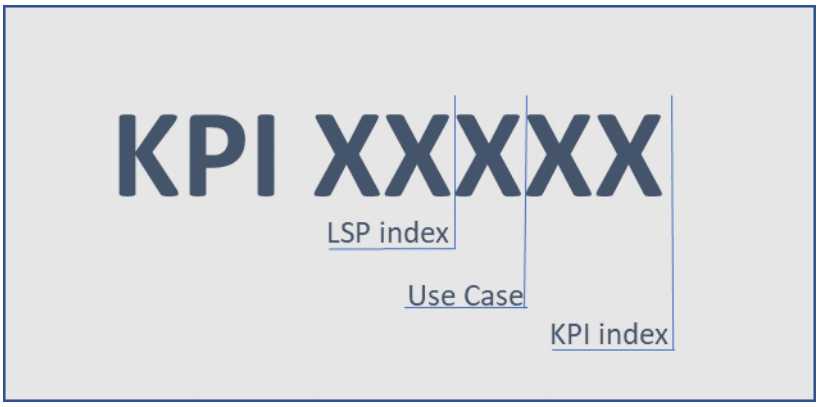

Figure 3: Pilot KPIs Notation

For example, KPI 3201, corresponds to LSP3, UC2 and KPI 01. KPI 11104 corresponds to LSP11, UC1 and index 04. Finally, the full list of KPIs of the corresponding LSPs can be found in APPENDIX V.

6.1 LSP1 (REN & RDN): Integrating off-grid Data with Condition based Monitoring for Enhanced Predictive Asset Maintenance

6.1.1 Use Cases

Asset management departments of TSOs are traditionally data intensive. Over the last years, with the ongoing digitalisation of power systems, the amount of data streams and data sources have significantly increased, showing the need for improved data analytics tools, in order to derive predictive models for assets maintenance. These models are intended to extend the lifetime of assets and optimise operational and maintenance assets costs, hence enabling sustainable risk management and, in a later stage, the integration of asset management with grid improved network operation.

The first UC aims to assess the condition of CBs in order to provide answers to key challenges in asset management: incident characterisation by analysis of COMTRADE files and incident feature extraction and subsequent implementation of optimal condition-based maintenance plans. Both are core elements of the electricity network and represent different challenges related to data processing, due to the different nature of the associated datasets.

The second UC aims to provide new data-based services which can be used to foster predictive maintenance strategies for TSO OHL tower infrastructures. Because overhead lines represent a major asset in power systems, the pilot aims to use inspection data (such as data from LiDAR technologies)

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to generate a semi-automatic maintenance plan for right of ways of overhead lines. The first objective of the UC is to automatically classify transmission towers in the field from point cloud scan data. On later stages, this knowledge will be used to perform identification of tower status and derive automatic condition-based maintenance plans.

For UC1, the proposed KPIs defined will assess that the analysis of COMTRADE incident data is done correctly, and incident types are accurately identified. Additionally, the maintenance plans generated by the tools to be developed, based on historical files, results in effective and improved maintenance plans.

For UC2, the goal is to evaluate the performance in classification and clustering of overhead transmission towers and to identify objects and components from point cloud data. Similarly, the KPIs will also measure the performance of newly derived maintenance plans.

6.1.2 KPIs

Table 9: LSP1 KPIs

LSP1 KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
1101: Number of real switching operations	For a given asset, track number of switching operations over time and perform timespan analysis	#	n/a	To be defined	UC1
1102: Circuit breaker fault clearance time	Clearing time is the sum of the circuit breaker's sensing time, unlatching time, mechanical operating time and arcing time.	To be defined	To be defined	To be defined	UC1
1103: Circuit breaker closing/opening time	Automatically detect opening and closing times from oscillography data with significant accuracy	To be defined	To be defined	To be defined	UC1

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LSP1 KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
1104: Fault categorisation accuracy	Accuracy in automatic classification of incident type based on COMTRADE file oscillography data.	%	To be defined	To be defined	UC1
1105: Incident cause categorisation accuracy (%)	Accuracy in relating CB tripping incidents with external causes.	%	To be defined	To be defined	UC1
1106: Accuracy of circuit breaker incident reports	The analysis of CB tripping incidents results in accurate measurements (including faulted current, secondary arc extinguishing time), which are automatically extracted from COMTRADE files.	%	To be defined	To be defined	UC1
1201: Accuracy identifying the tower type	Tower Types: Waist-type, double-circuit, Guyed-V, Tublar steel pole, Guyed cross-rope suspension, crossings	%	To be defined	To be defined	UC2
1202: Accuracy identifying the number of structural elements in the tower	Structural elements in the tower: Straight Elements, Main Leg, Diagonal bracing, Horizontal bracing	%	To be defined	To be defined	UC2

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LSP1 KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
1203: Number of different types of tower and RoW features/entities identified	RoW: It is a legal agreement that allows electric power supplier access to the property directly beneath and to either side of an electric power line. Also called an easement, the right-of-way allows the supplier to enter the property at any time, to perform maintenance or repairs to our equipment.	To be defined	To be defined	To be defined	UC2
1204: Meshed ground profile along the RoW	To be defined	To be defined	To be defined	To be defined	UC2
1205: Vegetation index mass	To be defined	To be defined	To be defined	To be defined	UC2

6.2 LSP2 (ELES): Cross-functional Integration of Grid Operation with Predictive Asset Management

6.2.1 Use Cases

Increasing stochastic power generation behaviour with high penetration of renewable energy sources is compounding the effects of the traditionally stochastic consumption on the power system operation. This requires high flexibility of transmission system, system operation and closely connected activities such as maintenance activities and the associated equipment outages. Furthermore, considering the asset management and the transition from time-based maintenance to condition base or predictive maintenance, the transmission system operation and planning are increasingly demanding.

Traditionally outage planning is typically done manually with minimal integration of various internal and external actors. The primary goal of the UC is to develop decision support tool to help the

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experienced human planners in maintenance scheduling process. Consequently, the outage planner will need less workhours to produce an outage plan. Data-driven descriptive and predictive analytics developed for this purpose can be used beyond this. The proposed UC has an ambition to go towards maintenance outage plan optimisation based on big data available today using various constraints and criterion algorithms.

This complex and multidimensional challenge will also support TSO ambition towards fewer outages, reduced outage duration, better outage utilisation for maintenance purpose, increased system reliability, easier and faster outage rescheduling, better coordination with outside partners, possibility of dealing with more complex outages and therefore operation of the power system closer to the operational limits.

Reversible analytics and better process understanding can be used to trigger planning for purchasing equipment with higher capabilities than typically needed with a view to determine how asset predictive maintenance timing may linearly affect TSO grid operational capability and power market transaction prediction, and how predictive models for grid assets maintenance may be affected by grid planning decisions.

The specific KPIs related to LSP2 are mainly designed to track that the functionalities of the developed tool are in line with the expectations of the TSO asset management process and data analytics development strategy.

6.2.2 KPIs

Table 10: LSP2 KPIs

LSP 2 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
2101: Planned outage duration	Total yearly planned outage duration in hours.	hours/year	Total annual planned outage duration in hours.	0,5 %	UC1
2102: Number of planned outages	The system total yearly number of planned outages.	number/year	Number of planned outages.	0,5 %	UC1
2103: AHI level (per asset and per fleet)	Asset health index.	To be defined	Asset health index formula is complex and different for different asset types.	0 % (no change)	UC1
2104: Faster outage plan	Person-hours needed for producing	Hours or days	Time evaluation of outage plan proposal and	50 %	UC1

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LSP 2 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
proposal and optimisation	maintenance outage plan proposal.		optimisation process		

6.3 LSP3 (ASM): Cross-Domain Cross-functional Integration of Predictive Asset Management and Grid Operation while coordinating with EVs smart charging

6.3.1 Use Cases

DSOs are facing severe network stability problems to the power distribution grid due to the increasing share of intermittent generation from renewable energy and to the new loads. This comes as energy storage and electric mobility are modifying the operating conditions of the assets, originally designed for almost steady and unidirectional power flow. Moreover, the envisioned penetration of e-mobility is going to significantly affect residual hosting capacity of the power distribution networks. In this respect, a DSO aims to maintain properly the existing infrastructure.

LSP3 consists of two UCs concerning the electricity distribution network. The objective in the first case is to demonstrate the optimisation of the management of land resources, such as electric vehicles and renewable generation sources, in order to avoid congestion and grid degradation, as well as to maximise self-consumption and reduce reverse power flow. The second UC aims to carry out predictive maintenance of transformers in secondary substations through the analysis of electrical, acoustic and environmental sensors, with the aim of increasing the lifespan of transformers.

Based on the above, UC 1 is essentially focused on flexibility, to reduce grid loading, so the KPIs are aligned to this objective. It was decided to set as key indicators those of the reduction related to the benefits that the grid receives from these mechanisms, namely the reduction of reverse power flow, the increase in the amount of energy that has been exchanged because of flexibility mechanisms, the increase in the number of users (drivers) involved, the increase in self-consumption and finally the reduction of power losses, highly related to cable loading.

UC2 is mainly focused on predictive maintenance, which has the direct aim of increasing the lifespan of transformers and reducing the costs associated with this activity. The KPIs chosen are therefore, in addition to the two mentioned above, those relating to the impact on the electricity grid and the benefits for the community, i.e., the classic indicators relating to continuity of supply: SAIDI, SAIFI and CAIDI.

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6.3.2 KPIs

Table 11: LSP3 KPIs

LSP 3 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
3101: Reduction of reverse power flow	Reduction of the reverse power flow at a substation	kWh - %	100 * [1 - (reverse power flow/Baseline reverse power flow)]	5%	UC1
3102: Amount of flexibility energy exchanged	This indicator evaluates the energy that is shifted over time due to flexibility services (called flexibility energy), with respect to the total amount of energy exchanged.	%	100 * [Flexibility_energy / Total_energy]	5%	UC1
3103: Number of customers included in the local flexibility mechanism	Number of customers included in the local flexibility mechanism	#customers - %	100 * [1 - (#customers/Baseline #customers)]	20 %	UC1
3104: Increase of Self-consumption	Self-consumption ratio is a metric used for quantifying the amount of energy produced and consumed locally relative to the total production that is locally available from on-site generation units.	%	100 * (energy produced by on-site generation - energy injected in the distribution grid during metering period t (kWh)) / energy produced by on-site generation	35 %	UC1
3105: Reduction of power losses in the distribution grid	Indicator for the optimisation of the grid operation	KWh - %	100 * [1 - (power losses/Baseline power losses)]	5%	UC 1
BO1: CAIDI	The Consumer Average Interruption Duration Index (CAIDI): Average	min/customers	duration of interruptions (min) / number of customers affected by the	20%	UC2

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LSP 3 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
	interruption time per consumer affected by the interruption per year		interruptions/year		
BO2: SAIDI	The System Average Interruption Duration Index (SAIDI): the number of interruptions per consumer per year	min/customers	number of interruptions/ numbers of all customers/year	28.963 minutes/(user*year)	UC2
BO3: SAIFI	The System Average Interruption Frequency Index (SAIFI): the average time of interruptions per consumer per year	min/customers	duration of interruptions (min)/ number of all customers/year	1.477N.outages/(user*year)	UC2
EIO1: Cost for asset maintenance and management	The average annual cost that is spent on asset maintenance and management	€	To be defined	30% (based on GA)	UC2
3201: Extended asset lifetime	Extended asset lifetime	Days - %	100 * [1 - (extended asset lifetime / initial asset lifetime)]	5 %	UC2

6.4 LSP4 (OEDAS): Cross-functional Predictive Asset Management for MV Grid Planning

6.4.1 Use Cases

The number of customers and demand for energy of DSO companies which are serving in large areas, are increasing day by day. Increasing number of distributed energy resources such as PVs and battery storages is also creating several problems such as voltage quality problems and capacity problems among others. Due to these reasons, distribution network operators need optimal network operations and for professional maintenance and asset management is required, in order to reduce the faults.

As the digitalisation in distribution grids increases, the monitorability of the system also increases and it creates large data pool. This is a situation that can be beneficial in preventing or predicting some problems in the distribution system.

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Reliability indexes such as SAIDI and SAIFI are very important indexes for DSO companies and these indexes directly reveal the performance of a DSO. Evaluation of the existing and historical grid data and using them as an input for predictive algorithms will increase the performance of distribution network with preventing possible faults.

Fault prevention will also increase customer satisfaction and will provide huge benefits from an economic and financial point of view reducing costs associated with maintenance, making investment planning more accurate.

6.4.2 KPIs

Table 12: LSP4 KPIs

LSP 4 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
BO2: SAIDI	The System Average Interruption Duration Index (SAIDI): the number of interruptions per consumer per year	min/customers	number of interruptions/ numbers of all customers/year	20%	UC1
BO3: SAIFI	The System Average Interruption Frequency Index (SAIFI): the average time of interruptions per consumer per year	min/customers	duration of interruptions (min)/ number of all customers/year	20%	UC1
4101: Reduction of faults	Measuring the reduction of faults occurrence (inverters, cells, SF6 sensors etc.) after predictive fault monitoring is implemented	#faults/year - %	Calculate the total number of faults before and after implementing the services. The formula is: (1 - (Faults_After/Faults_Before))*100	5% decrease	UC1
4102: Productive maintenance/preventing	Measure the change in the number of	#interventions/year -%	Calculate the total number of maintenance	3% decrease	UC1

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LSP 4 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
unnecessary maintenance	maintenance interventions (e.g., cleaning, plant system resetting, string repairing, electric board) after predictive maintenance is implemented		interventions before and after implementing the services. The formula is: (1 - (Interval_After/Interval_Before))* 100		
4103: Number of components replacements	Measure the reduction in components replacements (e.g., inverters, SF6 cells, etc.) after predictive fault monitoring is implemented	#components replaced/year - %	Calculate the total number of components replacements before and after implementing the services. The formula is: (1 - (Replacement_After/Replacement_Before))*100	5% decrease	UC1

6.5 LSP5 (CENTRICA): Cross-stakeholder Transfer Learning for Flexibility Assets Forecasting and Dispatching

6.5.1 Use Cases

Residential flexibility that is valorised on multiple energy services is becoming increasingly interesting. Residential assets such as electric vehicles, electric boilers, micro-CHP's or heat pumps are an untapped potential of flexible energy to integrate renewable energy by providing balancing services and mitigate grid congestion.

In order to control the assets efficiently, flexibility providers are building models of the assets to optimise their control actions. This can be a labour-intensive and time-consuming process that limits scalability. This challenge is approached by leveraging on data-driven algorithms in a Markov Decision Process (MDP) setting, such as reinforcement learning algorithms.

Flexibility providers, such as aggregators have access to very granular data over each individual asset such as power and voltage at fine-grained timescales (in the minutes to seconds range)" through proprietary metering solutions.

LSP5 is focused on demonstrating the developed analytics services on transfer learning and grid-secure

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dispatching. The KPIs defined for the proposed UCs, are aiming to different challenges. Regarding UC1, training data-driven models needs a considerable amount of data and can take time to converge to an optimal policy. Cross-context transfer learning is explored in this project as a solution and will be demonstrated in a real-life pilot. Regarding UC2 aggregators data can be leveraged in a cross-domain context to perform DR in a grid friendly way, by performing demand response in a way that supports the grid, mitigating voltage and congestion issues.

6.5.2 KPIs

Table 13: LSP5 KPIs

LSP 5 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
B04: DER flexibility	The aim of the KPI is to identify increase in DER flexibility that can be unlocked additionally with transfer learning, compared to Centrica's current services	% per year	To be defined	5%	UC1
5101: Number of days of historical samples required for training to fulfil the minimum cost saving target or related threshold	To validate the added value of transfer learning, the number days required for training a control policy with and without knowledge transfer is compared	#Days of training data	# samples/ dt, Sample: data sample with timestamp dt: Timestep	30	UC1
5102: Number of transfer learning agents deployed in staging/production environment	For monitoring the pilot progress, the number of trained agents deployed in production (i.e., on a real asset in the field) is monitored	Number of assets	n/a	50	UC1

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LSP 5 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
5201: Number of grid secure disaggregation agents deployed in staging/production environment	For monitoring the pilot progress, the number of grid secure agents deployed in production (i.e., on a real asset in the field) is monitored	Number of assets	To be defined	50	UC2

6.6 LSP6 (EKL, BORZEN & CS): Coordinating grid-owned and behind-the-meter assets management prediction for improved grid operation and near real time power market operation settlement

6.6.1 Use Cases

The UCs relate to the optimised management of grid connected assets. i.e., small-scale RES and demand-response flexible loads, while the rationale is in the design of data and analytic services marketplace allowing various stakeholders of the energy supply value chain to collaborate and facilitate business relations on a P2P.

The scope of LSP6 also aim to address some of the key challenges, that arise as a consequence of legislative changes. These are primarily the issue of quantifying the proposed service in terms of energy, provided that the supplier and the (independent) aggregator are two distinct entities and that there might not be separate metering and the issue of potential compensations and models, within the bounds of CEP.

The aim of this pilot is thus to enhance the coordinated management of grid and third party owned grid connected assets and optimise their flexibility potential with a view to support different and new business models and subsequent anticipated settlement. The DSO's reactive (SCADA) and preventive (protection scheme) operational applications will be complemented with proactive (schedules) and corrective (mode of operation, set point modulation, etc.) operation schemes based on data analytics. Internally within the DSO (intra-stakeholder) this demands for the integration of growing data stores of disparate systems (e.g., meter data management, customer information from smart meters, outage management, etc.) with the aim of obtaining critical insights to enhance operations as well as strategic decision-making. The final expected outcome is to:

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- increase efficiency and reliability of network operation via coordinated optimisation and management of connected assets,
- include different possible models of consumer participation, design of rules, settlement process and assessment criteria and
- design infrastructure with reliable and near real-time metering data aggregation to support analytical tools.

6.6.2 KPIs

Table 14: LSP6 KPIs

LSP6 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
6101: Reliability and efficiency of the power network	Improvement of the electricity quality indicators regarding level of undelivered electricity, in terms of reliability and the reduction of the MV/LV transformer overloads.	%	SAIDI, SAIFI	To be defined	UC1
6102: Cost reduction for management and maintenance of the power network assets	This indicator will be available when the pilots will be up and running and is in relation with SAIDI.	%	Saving/costs in one year	6%	UC1
6103: Number of flexible prosumers	This KPIs will be an assessment of the increase of flexible prosumers, as this pilot will be the start of flexibility potential evaluation.	#	Real/potential	0.125	UC1

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LSP6 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
6104: Contracted/activated flexible power provided to cover the DSO needs	This KPI will be about several innovative, data driven business modes per MV/LV transformer station.	#	Flex. MW/transformer nominal power	>0.1	UC1
6201: Impact on final asset (consumer / producer) for different possible models	The difference in the financial outcome of consumer/producer for the corresponding models	€	Income based on activations	> 0	UC2
6202: Scalability of models (including equipment needs)	The possibility of implementing models on a larger number of end users	# of end users	number of all end users	> 10	UC2

6.7 LSP7 (ENELX): Predictive Analytics Forecasting of storage optimised operation for improved market reserve participation

6.7.1 Use Cases

Due to the diffusion and use of renewable resources combined with storage systems as key-value of the de-carbonisation process, it is very important to be able to predict any critical conditions that can negatively affect performance, causing disservices on front-of-meter (FTM) and behind-the-meter (BTM) applications.

LSP7 UC is focused on BESS plants integrated in the power system in order to provide large-scale energy storage system testing activities for grid applications.

The primary aim of the pilot is to create a BESS predictive maintenance tool and related procedures, starting from condition-based monitoring, in order to identify under-performance cases and predict critical events thus to improve BESS reliability and, consequently, improve plant performance while reducing operating maintenance costs.

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In order to achieve the goal is to integrate physical equipment into the testing environment, and to collect and store the data produced into a data acquisition system.

6.7.2 KPIs

Table 15: LSP7 KPIs

LSP7 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
EI01: Cost of asset maintenance and management	Reduction of annual cost for asset maintenance and management	To be defined	To be defined	To be defined	UC1
7101: Number (percentage) of DAS measures collected by physical equipment	This KPI measures the number of daily measures produced by physical sensors and collected into the Data Acquisition System.	%/day	[Number of measures for single sensor/(86400/Sample rate of sensor in seconds)]*100	>=95%	UC1
7102: BESS under performance areas identification	This KPI measures the number of BESS under performance areas identified before system critical alert notification.	%	(Number of identified up areas/Total up areas)*100	>=65%	UC1
7103: Reaction time before system under performance event	This KPI measures the time identification before system under performance event (according to BESS under performance areas identified).	Hours	To be defined	>=10	UC1

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6.8 LSP8 (UNIWA/TILOS): Predictive Demand and Generation Forecasting for Optimised Local Energy Community Management

6.8.1 Use Cases

Non-interconnected island electricity systems are largely dependent on the use of imported oil for electricity generation purposes. This increases production costs considerably, while also introducing technical limitations to the large-scale exploitation of RES power generation. At the same time, significant load variation noted over the course of the year further challenges increased RES penetration, with many island systems presenting increased shares of RES curtailments, especially during the winter (non-touristic) period. This reflects upon the need for the introduction of flexibility means including the components of storage, demand response, vector coupling and advanced energy management relying on big data analytics and modern forecasting techniques. Similar portfolios and bundles of solutions may unlock the potential for further RES exploitation, offering at the same time readily available tools for local community scale actors.

The scope of LSP8 is to support peak shaving and load shifting decisions based on electricity demand and RES production forecasts. In this respect, the selected KPIs' goal should be the limitation of the complexity associated with performance tracking and measurement, by focusing on practical key indicators. The main objectives of LSP8 are the reduction of energy cost and CO2 emissions, as well as the stabilisation of the operation of the island's energy systems and the minimisation of the energy lost from renewable sources.

6.8.2 KPIs

Table 16: LSP8 KPIs

LSP8 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
EI04: Network management improvement	Improvement of network management through reduced gap between predicted and metered network loads	%	Predicted – metered/metered	20%	UC1

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LSP8 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
EI05: Use of renewable energy	Increased use of renewable energy measured as amount of RES-based generated energy integrated in the grid network by leveraging on predictive load and generation forecasting	%	RES Production/Total Production	30% increase	UC1
8101: Specific Cost Savings	This KPI measures the specific cost savings achieved in the island of Tilos due to better allocation of energy uses (e.g., water pumps), resulting in improved alignment between the energy produced and the energy consumed.	Euros/MWh	Calculate the annually weighted energy consumption specific costs before and after implementing the BD4NRG services. The formula is: Specific Cost_before - Specific Cost_after. Costs are HDD/CDD-adjusted	up to 5% decrease in specific cost	UC1
8102: Load Demand Volatility	This KPI measures the load demand volatility in the island of Tilos at an hourly level. Indicatively, peak shaving services have been implemented to support less volatile energy consumption patterns across the day.	(% decrease of the standard deviation of the energy consumption)	Calculate the standard deviation of the energy consumed in the island of Tilos before and after implementing the BD4NRG services. The formula is: (StDev_before - StDev_after) / StDev_before. The calculations are performed at an hourly level and on a yearly basis.	up to 5% decrease in standard deviation	UC1
8103: Availability of Renewable Energy Sources	This KPI measures the ability of energy management systems to	(% increase in annual operating hours)	Calculate the total number of hours that the PV plant operated before and after	To be defined	UC1

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LSP8 – KPIs Table

KPI	Explanation	Unit	Formula	Indicative Target	Related Use Case
	accurately detect and monitor anomalies in renewable energy production sources, namely photovoltaic plants.		implementing the BD4NRG services. The formula is: (Sum_of_hours_ After - Sum_of_h ours_Before)		
8104: Annual RES Shares	This KPI measures the recovery of RES (wind) curtailments achieved through the implementation of ML forecasting methods and load shifting DR strategies for a versatile pool of flexible loads.	(% increase in annual RES (wind) shares)	Calculate the total shares of RES for the coverage of flexible loads before and after implementing the BD4NRG services. The formula is: (Annual_RES_Sha res_After - Annua l_RES_Shares_Be fore)	up to 10% increase in annual RES shares	UC1
8105: Specific CO2 Savings	This KPI measures the specific CO2 savings achieved in the island of Tilos due to better penetration or renewable energy sources (e.g., PV plants), resulting in less losses.	(kg CO2/MWh)	Calculate specific CO2 emitted before and after implementing the BD4NRG services. The formula is: Specific CO2_before - Specific CO2_after. Emissions are HDD/CDD and Solar Radiation-adjusted. National CO2 emission factors are used to compute specific CO2 savings based on the correspondin g energy savings.	up to 5% decrease in specific emissions	UC1

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6.9 LSP9 (ENERC): Collaborative aggregated energy generation prediction

6.9.1 Use Cases

Large scale solar power plants are driven by a large number of components that regularly need maintenance, observation, troubleshooting and monitoring. Maintenance actions such as the cleaning of the CPV panels (especially important in this kind of PV technology) is done on a periodical basis instead of being done according to the production conditions. Systems observation and external observation capacities could be combined to increase overall system efficiencies and performance. The evolving drone observation technologies would allow for large fields scanning in addition to the on-site generated data. This new technology can produce better results if various data types are analysed.

The use of big data and AI applications in this pilot can help improve all the above existing and future operations for the operator of the large-scale production sites, self-consumption operators and deliver services to the grid operator increasing grid management capacity and coordination. Maintenance can be done on a need basis and fault prediction algorithms can be created for some of the components. Production forecasting can also be improved by coupling weather forecast data with production models. Better production forecasts also enable more grid services that can be provided.

The UC1 specific KPIs mainly focus on how the LSP9 maintenance operations are improved related to the established goals, namely, to implement optimal maintenance scheduling of operations, to reduce unnecessary or due maintenance, to implement predictive fault monitoring in order to perform troubleshooting before faults occur and to implement production forecast using weather data and production models to add value to the services provided.

The main objectives of LSP9 are to measure and optimise the number of maintenance interventions (equipment faults, replacements, repairs), optimise the cleaning operations and resources activation; to reduce energy losses and to access how many types of components at the CPV plant are integrated in an edge architecture.

6.9.2 KPIs

Table 17: LSP9 KPIs

LSP9 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
EI01: Cost of asset maintenance and management	Compare annual cost of asset maintenance and management	€/year	Compare the difference in maintenance and management costs before and after BD4NRG	To be defined	UC1

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LSP9 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
			services are implemented		
EIO6: Energy efficiency increase	Measure the increase in energy efficiency after predictive maintenance is implemented	%/year	Compare the difference in energy production before and after BD4NRG services are implemented by comparing both with ideal scenario (no losses, calculated with weather data and energy models)	3% decrease	UC1
9101: Number of equipment faults	This KPI measures the reduction of faults occurrence (inverters, CPV trackers, cells, etc.) after predictive fault monitoring is implemented	#faults/year - %	Calculate the total number of faults before and after implementing the BD4NRG services at the CPV plant. The formula is: (1 - (Sum_of_faults_After/Sum_of_faults_Before))*100	To be defined	UC1
9102: Number of maintenance interventions	This KPI measures the change in the number of maintenance interventions (e.g., cleaning, plant system resetting, electric board, physical damage) after predictive maintenance is implemented	#interventions/year - %	Calculate the total number of maintenance interventions before and after implementing the BD4NRG services at the CPV plant. The formula is: (1 - (Sum_of_interv_After/Sum_of_interv_Before))*100	To be defined	UC1

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LSP9 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
9103: Number of components replaced and repairs	Measure the reduction in components replacements and repairs (e.g., inverters, CPV trackers, string, cells, etc.) after predictive fault monitoring is implemented	#components replaced and repaired/year - %	Calculate the total number of components replacements and repairs before and after implementing the BD4NRG services at the CPV plant. The formula is: (1 - (Sum_of_interv_ After/Sum_of_int erv_Before))*100	To be defined	UC1
9104: Number of cleaning operations and the related resources activation optimisation	Measure the change in the number of cleaning operations after predictive maintenance is implemented, evaluating the optimisation in the cleaning cycles (including scheduling)	#interventions/y ear - %	Calculate the total number of cleaning operations before and after implementing the BD4NRG services at the CPV plant. The formula is: (1 - (Sum_of_clean_A fter/Sum_of_clea n_Before))*100	To be defined	UC1
9105: Number of enabled edge components	Assess how many types of components installed were integrated in an edge architecture model (e.g., inverter, tracker, datalogger, gateway)	#edge components	Number of type of components that are edge components at the CPV plant.	>1	UC1
9201: Digital twins setting up and performance optimisation	Optimal setting of architectures integrating systems enabling data share from	# of digital twins	To be defined	>1	UC2

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LSP9 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
	available data sources				
9202: Data streams (energy production, energy consumption, building energy efficiency, energy related carbon footprint)	Assess how many different data streams are offered	# of data streams per type	To be defined	>4	UC2

6.10 LSP10 (CARTIF & VEOLIA): Predictive and Prescriptive Analytics for improved Energy Performance Certificates Reliability

6.10.1 Use Cases

EPCs and their accompanying assessment methodologies are well-established in many EU countries. In this context, even when the potential of EPCs to act as catalyst to support the energy transition and boost energy refurbishments is high, a review of these schemes has shown different interpretations, approaches and levels of compliance. As a result, this ultimately leads to a climate of distrust by the public in the whole process and in the actors involved in it.

Improvements to these schemes should be implemented in a coherent and cost-effective manner, even though it will require a great amount of time and resources for the whole approach to Energy Performance Assessment and Certification schemes to be altered based on the currently identified shortcomings.

However, the current increase of data availability that can support EPCs generation, as well as big data techniques bring new opportunities to overcome these barriers, enabling scalable integration and management of large heterogeneous cross-domain and cross-stakeholders amounts of data in a harmonised way, from real-time smart meters to relevant contextual information. Thus, an opportunity for reviewing the implementation of EPC schemes is presented with a more consistent, reliable, user-friendly, cost-effective and validated methodology of what EPCs should be used for in the future, while comparable good quality and compliance with EU legislation are granted. To this end, predictive and prescriptive analytics will be developed to support the implementation of next generation EPC.

The main objectives of LSP10 are to increase the reliability in EPCs as an element to determine the

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degree of improvements of buildings energy performance and to use analytics for determining the optimal building energy retrofitting planning. For this, the KPIs selected should be focus on the measurement of the people trust on the EPCs values, in the information that can be added for improving the calculation of the EPCs and in the automatic results that it can offer. In this context, the general KPIs related to sources and resources are of utmost importance.

6.10.2 KPIs

Table 18: LSP10 KPIs

LSP 10 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
BO6: EPC gap reduction	EPC gap reduction between the predicted and the actual energy efficiency performance	Number of updates/unit of time	Calculation of EPC gap reduction between the predicted and the actual energy efficiency performance (mainly energy demand and consumption)	20%	UC1
10101: EPCs calculated	Number of estimated EPCs that can be calculated using the service developed for LSP10	#	Counting the EPC calculated by the tool	1000	UC1
10102: Building typologies included in the next generation EPCs	Number of different building typologies that can be found in the estimated EPCs	#	Checking the different typologies managed by the tool	6 or 7	UC1
10103: Trust on Energy Performance Certificates	This KPI measures the increase in the trust on Energy Performance Certificates through the Energy savings verification deployed in LSP.	Likert Scale	To define values 1 - 5 of the Likert Scale	3 or 4	UC1
10104: Maximum refres h rate reached	Refresh rate for data used by the service. It is important to note that different sources could have different refresh rate.	number of updates/units of time	To be defined	1/hour	UC1

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6.11 LSP11 (AJSCV & VEOLIA): Weather-enhanced building thermal comfort prediction to enable energy efficiency reliable forecasting

6.11.1 Use Cases

In the proposed UC, cross-domain integration of building/district energy consumption data with off-grid weather information will take place to enable thermal comfort analytics-based prediction applications at building level, and related trade-offs with energy efficiency, with a view to support near real time comfort-enhanced decision-making by building or district operator.

ML algorithms will be used to bridge the gap between controllable building parameters and thermal comfort, by conducting an extensive study on the efficacy of different ML techniques for modelling comfort levels, while trading off with energy efficiency. Data of demand forecast, evaluation weather forecast, and comfort are necessary to perform the analysis.

The expected benefit will be a finer grained and more accurate thermal comfort prediction, which is expected to be linked linearly with HVAC set points and actions on controllable loads, while taking into consideration potential changes in energy consumption and how this could be reflected into building energy efficiency.

6.11.2 KPIs

Table 19: LSP11 KPIs

LSP11 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
B05: Building comfort conditions	Increase of thermal comfort	To be defined	To be defined	30%	UC1
1101: Energy Savings from Thermal Comfort Actions/Measures	This KPI measures the decrease in energy consumption due to the conducted analysis on heating management in the examined buildings, while also maintaining the quality of life of tenants in high levels.	%	n/a	To be defined	UC1
1102: Energy Efficiency Measures Proposed	This KPI measures the number of measures	#	n/a	To be defined	UC1

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LSP11 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
	proposed towards energy efficiency on buildings based on real social housing energy consumptions.				
1103: Number of Buildings Involved	This KPI measures the number of buildings that participate in the thermal comfort scenarios.	#	n/a	To be defined	UC1

6.12 LSP12 (LEIF): Predictive Analytics for Energy Efficiency Investments de-risking

6.12.1 Use Cases

Energy efficiency projects are often fragmented, with high transaction costs, while with no evidence-based platform that would allow investors and financial institutions to assess the risk-, the financial performance of the investments, as well as the impact on energy efficiency. The capability offered by emerging near big data analytics to integrate cross-domain financial and energy consumption is the key for building the necessary market confidence in energy efficiency projects and making them an attractive investment asset class. The use of historical data pooled from major market segments can encourage more energy efficiency investments and de-risk investments.

The chosen KPIs are mostly related to the return on financial investment in the implementation of energy efficiency measures. It is highly important for stakeholders involved in the implementation of the project to be aware of how much heat energy savings can be obtained with a specific amount of investment. One of the criteria for evaluating energy efficiency projects when allocating grant funding is the potential reduction in CO2 emissions, as understanding the effectiveness of investments in CO2-reducing activities are critical. Finally, in order to assess the efficiency of investments, it is also necessary to assess the efficiency of the building's own energy consumption indicators.

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6.12.2 KPIs

Table 20: LSP12 KPIs

LSP12 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
B07: Energy efficiency investment de-risking	This KPI will measure the de-risking on energy efficiency investments	%	Calculation of cost reduction related to the predicted and the actual energy consumption	20%	UC1
12101: Investment in energy efficiency	This KPI measures the most effective investments for energy consumption reduction.	kWh/euro per year	(Total use of energy per year in kWh on-site before the implementation in the pilot - Total use of energy in kWh on-site after the implementation in the pilot) / Total investment costs for pilot.	1,5 kWh/euro per year	UC1
12102: Grant financing in energy efficiency	This KPI measures the most effective grant financing for energy consumption reduction.	kWh/euro per year	(Total use of energy per year in kWh on-site before the implementation in the pilot - Total use of energy in kWh on-site after the implementation in the pilot) / Total grant financing for pilot.	2,5 kWh/euro per year	UC1
12103: Investment CO2 efficiency	This KPI measures the most effective investments for CO2 reduction.	kgCO2/euro per yea	(Total use of energy per year in kWh on-site before the implementation in the pilot - Total use of energy in kWh on-site after the implementation in the pilot)*CO_2 coefficient / Total investment costs for pilot	0,5 kgCO2/euro per year	UC1
12104: Grant financing CO2 efficiency	This KPI measures the most effective grant financing	kgCO2/euro per year	(Total use of energy per year in kWh on-site before the	0,75 kgCO2/euro per year	UC1

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LSP12 – KPIs Table					
KPI	**Explanation**	**Unit**	**Formula**	**Indicative Target**	**Related Use Case**
	for CO2 reduction.		implementation in the pilot - Total use of energy in kWh on-site after the implementation in the pilot)*CO_2 coefficient / Total grant financing for pilot		
12105: Renewable energy efficiency	This KPI measures the most effective investments for renewable energy.	kWh/euro per year	(Total produced renewable energy in kWh on-site after the implementation in the pilot) / Total investment costs for pilot.	5 kWh/euro per year	UC1
12106: House heating / cooling efficiency	This KPI measures the house heating or cooling efficiency.	kWh/m2	(Total use of energy per year in kWh on-site after the implementation in the pilot for house heating or cooling) / Total house area.	50 kWh/m2	UC1

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7 Summary and Next Steps

Deliverable D6.1 – "Pilot Operation, Engagement and M&V Plan" presents the framework that will be used to evaluate BD4NRG's tools and services by the pilot demonstrators and the monitoring process as well. It also presents the context under which the analytics services will be deployed by offering a streamlined process that will be followed. A comprehensive set of KPIs, both horizontally and pilot specific has been identified, providing an efficient way of evaluation aligned both on the BD4NRG' vision and goals as a project, and the pilots' targeted goals. It also presents an initial plan to measure the user satisfaction of BD4NRG's tools and services and provides the monitoring process for all pilot activities.

The next steps after this deliverable are:

- Deployment of the user satisfaction methodology, by creating the first set of questionnaires for the Pre-Pilot Cycle which will be reported in deliverable D6.2 – ""BD4NRG Pilots Synergies, Evaluation and Feedback - First Release" at M15 (March 2022).
- Finalisation of the M&V plan by M14 (February 2022), upon completion of the 1st technology release and the subsequent Pre-Pilot Cycle phase. The activities will focus on finalising the pilot specific KPIs, based on the identified UCs and possible new ones that may be identified.
- Baseline assessment for each pilot that will be reported on deliverables of WP7 – ""BD-4-NET" Large Scale Pilots: Increasing the Efficiency and Reliability of the Electricity Network", WP8 – ""BD-4-DER" Large Scale Pilots: Optimizing the Management of Assets (DER - Distributed Energy Resources) Connected to the Grid" and WP9 – ""BD-4-ENEF" Large Scale Pilots: De-Risking Investments in Energy Efficiency and Increasing the Efficiency and Comfort of Buildings" and use as input the information of deliverable D6.1.
- Tracking and monitoring of pilot demonstration activities of the operation and engagement plan (section 4), based on the final M&V plan and the baseline assessment report and the corresponding evaluation periods as described on section 2.1. The monitoring activities will be reported on the next deliverables of WP6, i.e., D6.2 – "BD4NRG Pilots Synergies, Evaluation and Feedback - First Release" at M15 (March 2022), D6.3 – "BD4NRG Pilots Synergies, Evaluation and Feedback - Second Release" at M28 (April 2023) and D6.4 – "Final Evaluation, Impact Assessment and Adoption Guidelines" at M36.

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APPENDIX I: Pilots Goals

Pilot	Use Case	Expected Goals
LSP1	UC1: AI methods applied to Condition-based monitoring of Circuit Breakers (CB)	• Categorisation of cause of/faults using unsupervised clustering methods, integrating off-grid data • Estimate likelihood index of failure (actual failure or reduction of performance) for CBs in order to support predictive maintenance
	UC2: Semi-Automatic Maintenance Plan for Right-of-Ways (RoW) in Overhead Lines (OHL)	• Classification of towers existent in the field • Usage of unstructured scan data to identify and evaluate OHL Towers condition • Derive maintenance plan based on state of RoW of OHL assessed with data mining techniques
LSP2	UC1: Maintenance Plan Optimisation	• Automatic generation of Gantts chart for outage plan proposal • Analytical planning approach • Flexibility of planning • Digitalisation of planning • Maintenance planning considering a wider range of influencing parameters • Use of criteria function • Reduction of effort for producing the plan • Increased role of data in maintenance planning • Use of analytical reversibility approach to determine the influence of introduction of equipment with higher capabilities
LSP3	UC1: Efficient management of flexibility resources for supporting grid operation	• Definition and implementation of optimal scheduling and usage of RES and EVSE for reducing equipment loading during normal service. • In case of degraded service, RES and EVSE will support DSO whilst it implements topology changes and repairing activities.
	UC2: Anticipated prediction of asset failures	• Definition and implementation of new plan for asset replacement and maintenance based on predictive analytics
LSP4	UC1: Predictive maintenance and fault prediction for MV grid and cross functional asset management	• Reduce faults on MV grid • Support maintenance activities and processes • Increase efficiency of operations

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Pilot	Use Case	Expected Goals
LSP5	UC1: Controlling residential demand response assets from the transferred knowledge from a MDP setting.	• Developing knowledge transfer algorithms for residential demand response • Demonstrating transfer learning on residential demand response in the field, with a full end-to-end software chain
	UC2: Using residential DR assets to retrieve local grid information for aggregation activations	• Mitigate voltage and congestion issues by leveraging high granular measurements from flexible devices
LSP6	UC1: Identification of flexibility potential, based on near-real time data	• Increase efficiency and reliability of network operation • Infrastructure design with reliable and near real-time metering data • Exploiting the flexibility potential identified at the substations to defer investments or maintenances
	UC2: Independent aggregator flexibility activation, quantification and settlement	• Determine possible/optimal quantification methods for independent aggregator activation • Determine possible/optimal settlement models • Determine needed data structures and timing for implementation in larger scale • Determine possible models, adequate for customers with metering resolution above ISP (Imbalance Settlement Period)
LSP7	UC1: Predictive analytics forecasting of storage optimised operation for improved market reserve participation	• Physical equipment installation and Data Acquisition System (DAS) upgrade. • Market scenario identification and grid services selection. • Test protocol design and execution. • DAS integration with BD4NRG platform. • BESS condition-based monitoring procedures implementation. • BESS condition-based monitoring procedures testing (under-performance areas identification).
LSP8	UC1: Optimal management strategies for cross-infrastructure flexibility resources to support higher RES shares at the island community level.	• Definition of optimal scheduling and usage of deferrable loads of different elasticity to achieve higher RES shares at local (island) community level • Development of a portfolio of services for economically optimal management of island municipalities' deferrable loads • Definition of optimal scheduling of deferrable loads for offering distribution grid services at the island level (e.g., peak shaving)
LSP9	UC1: Optimising and improving management and prediction of DER	• Definition and implementation of optimal scheduling of maintenance operations to reduce unnecessary or due maintenance • Definition and implementation of predictive fault monitoring in order to perform troubleshooting before faults occur

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Pilot	Use Case	Expected Goals
	production	• Definition and implementation of production forecast using weather data and production models to add value to the services provided
	UC2: Energy sector digital twin	• Aggregate energy consumption • Monitor building energy efficiency • Improve energy resource management • Creation of consumption electricity map and energy related carbon footprint • Create historical data sets
LSP10	UC1: Predictive and Prescriptive Analytics for improved Energy Performance Certificates Reliability	• Overcome "reliability" barriers that hinder the high potential of EPCs • Contribute to increasing the use of EPCs in the EU and among end-users • Calculate next generation of EPC v2.0 (or dynamic EPC). • Provide recommendations for Energy Conservation Measures (ECMs) to improve the EPC label • Dynamically update the EPC label • Contribute to establish connections between EPCs and standards/ other relevant approaches
LSP11	UC1: Weather-enhanced Building Thermal Comfort Prediction to Enable Energy Efficiency Reliable Forecasting	• Cross-domain integration of building/district energy consumption data with off-grid weather information to enable thermal comfort analytics-based prediction applications at building level, and related trade-offs with energy efficiency. • Increase of accurate thermal comfort predictions by taking into consideration potential changes in energy consumption and how it could be reflected into building energy efficiency. • Creation of new business models to increase the efficiency and comfort of buildings and big data analytics to provide information to the private sector.
LSP12	UC1: De-risking energy efficient investments	• Analysing best and financially low risk refurbishment option in energy efficiency • Evaluate quickly and easily key performance indicators for projects • Explore past and future projects in order to make a profound risk measurement and evaluation

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APPENDIX II: Pilot Data Template

Description	Volume	Velocity	Variety	Veracity
Dataset Name	GB per year	Storage Frequency	Communication Interfaces	Ownership
Dataset Type	Starting Date	Read Frequency	Interface Documentation	Reliability
Variable Name	Ending Date	Update Frequency	Processing Needs	Transmission Security
Variable Description	Sampling Frequency	Bandwidth Limitation	Data Structure	
Measurement Units	Percentage of Missing Values		Related Standard	
	Storage Format			

The above pilot data template was handed to all pilots for filling the required information as each cell per category is an input field. The template was given in the form of a Microsoft Excel file, but in terms of readability is presented in the form of a table. Below a picture of the template is presented, as handed to the pilots.

Description					Volume						Velocity				Variety					Veracity		
Dataset name	Dataset type	Variable name	Variable description	Measurement Units	GB/year	Starting date	Ending date	Sampling frequency	Percentage of missing values	Storage format	Storage frequency	Read frequency	Update frequency	Bandwidth limitation	Communication interfaces	Interface documentation	Need processing	Data structure	Related standard	Ownership	Reliability	Security of the transmission
Weather data	Dynamic	Temperature	Temperature measured at weather station AIA, Greece	Celsius degrees	100 MB	01-10-19	Ongoing	18 measurements/day	<10%	SQL	Daily	Every minute	Daily	NO	https	YES	NO	Numeric	SQL	Open data source	High	SQL database security - login and VPN needed
Weather data	Dynamic	Humidity	Humidity measured at weather station AIA, Greece	%	100 MB	05-10-19	Ongoing	24 measurements/day	<20%	csv	Daily	Every minute	Daily	NO	https	YES	NO	Numeric	SQL	Private	Medium	SQL database security - login and VPN needed
Weather data	Dynamic	Wind speed	Wind speed measured at weather station AIA, Greece	m/s	100 MB	05-10-19	Ongoing	5 measurements/day	<25%	json	Daily	Every minute	Daily	NO	https	YES	NO	Numeric	SQL	Private	Medium	SQL database security - login and VPN needed
XXX	Semi-static																	character strings (plain file)				
XXX	Static																					
XXX																						
XXX																						

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APPENDIX III: Analytics Services Description Template

ANALYTICS SERVICES DESCRIPTION TEMPLATE

LSP[X] – Technical Partner's Name

DD/MM/YYYY

This document serves as a preliminary description of the Services that technical partners will develop. Technical partners should provide a description of their proposed services along with additional information.

Service Profile	
Service name	
Version	
Date	
Author	
Notes	*This version only contains elementary fields to describe the basic idea of the service*.

Service Description

Version Management

Version No.	Date	Name of Author(s)	Approval Status
1.0			
1.1			
1.2			

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Scopes & Objectives

Scope and objectives of Service

Scope and Objectives of Service	
Scope	*Describe with one sentence what your service does*
Objective(s)	*Describe with one sentence what is the final benefit that can be achieved with your service*
Type of Service	*Please indicate what type of analytic(s) the service serves (declarative, prescriptive, predictive etc. as described in WP4)*
Short Summary	*Please describe in a few sentences what does your service does (i.e., Takes energy consumption data from solar plants, weather data, grid data etc. and provides a prediction for future production and points of interests. The prediction is done with ML models and the output is a chart that the user can get information)*
Possible LSPs	*Please indicate identified LSPs that the service could be applied*
Matching Table	*Please find*

Data Information

Data Information	
Input	*Please indicate the data inputs that are needed, in order for the service to work (i.e., Weather data-temperature, energy consumption etc.). Please check* **Table A** *if you need to share more analytical information regarding the data.*
External Datasets	*Please indicate if any external open-source datasets are or will be used in this service.*
Techniques	*Please indicate the type of AI-based techniques that are or will be used in the service, if any (i.e., Regression, Clustering, ANN, SVM etc.)*
Output	*Please indicate here only if the output of the service can be available for processing, and its format (i.e., The results of the service can also be extracted to csv files, there is an existing API etc.)*

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Relevant Projects

Relevant H2020, EU projects or other useful projects
Please indicate here any H2020 or EU project that this service is applied to or is using components of.

Project	Type of Project	Component
(Big Data Ocean)	*(H2020/EU)*	*(API to feed weather data)*

General remarks

Service status and additional documentation if existing
Please indicate here if the service to be deployed is new, or if it is based on previous developments. Also, if it is currently being expanded in another project and if those new functionalities are to be provided within BD4NRG, or if there is relevant additional documentation that can be shared and would be of use within BD4NRG.
Other comments
Please indicate here any additional information that was not provided in the previous tables and that can be important to know when considering the use of your service.

Pilot/Services Mapping Table

Please indicate the service(s) you describe above to which technical Task corresponds and to which LPS(s) and specific Use Case(s) applies.

BD4NRG Analytics Services	Technical Partner	Task	LSPX1	LSPX2
System diagnostics, Predictive maintenance & Failure detection	**XX**	**T4.2**	UC 1	UC 1
….				

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Table A: In this table, an analytical overview of the required data input can be described

Type of Data	Volume	Interval	Most suitable format	Critical
(Temperature)	*5gb or 2 years amount of data*	*Hourly*	*csv files, API*	*Here a yes/no means that if this type of data is critical to run the service*

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APPENDIX IV: Pilot Infrastructure Template

PILOT INFRASTRUCTURE

LSP[X]

BD4NRG platform will be able to accommodate diverse and interoperable type of data under its premises. In that context, data infrastructure and existing methods are important to be taken under consideration at this early level.

- Please mention the communication interface or protocols that your data could be accessed.

(Please answer)

- Would it be possible to access your data infrastructure through a dedicated API? If you are currently using one, would you provide relevant documentation?

(Please answer)

BD4NRG platform will also rely on standardised data models. This is aligned with the AI4EU project and relevant activities that could help share AI resources produced in European projects.

- Please mention any standardised data model that you are currently using (i.e., SAREF, FI-WARE).

(Please answer)

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APPENDIX V: List of KPIs

LSP1	LSP2	LSP3	LSP4	LSP5	LSP6	LSP7	LSP8	LSP9	LSP10	LSP11	LSP12
1101	2101	BO1	B02	BO4	6101(BO2/BO3)	EIO1	EI04	EIO1	BO6	BO5	BO7
1102	2102	BO2	B03	5101	6102(EI01)	7101	EI05	EIO6	10101	1101	12101
1103	2103	BO3	4101	5102	6103(EI02)	7102	8101	9101	10102	1102	12102
1104	2104	EI01	4102	5201	6104	7103	8102	9102	10103	1103	12103
1105		3101	4103		6201		8102	9103	10104		12104
1106		3102(BO4)			6202		8103	9104			12105
1201		3103(EI02)					8104	9105			12106(EI06)
1202		3104					8105	9201			
1203		3105						9202			
1204		3201									
1205											

In parenthesis, the suggested KPIs by pilots that could indirectly measure the BO and EI KPIs is being shown

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